

SCIENCE

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SOME ASPECTS OF PROGRESS IN MODERN ZOOLOGY¹

IT is our privilege to live in a time of almost unexampled progress in natural science, a time distinguished alike by discoveries of the first magnitude and by far-reaching changes in method and in point of view. The advances of recent years have revolutionized our conceptions of the structure of matter and have seriously raised the question of the transmutation of the chemical elements. They have continually extended the proofs of organic evolution but have at the same time opened wide the door to a reexamination of its conditions, its causes, and its essential nature. Such has been the swiftness of these advances that some effort is still required to realize what remarkable new horizons of discovery they have brought into view. A few years ago the possibility of investigating by direct experiment the internal structure of atoms, or the topographical grouping of hereditary units in the germ-cells, would have seemed a wild dream. To-day these questions stand among the substantial realities of scientific inquiry. And lest we should lose our heads amid advances so sweeping, the principles that guide scientific research have been subjected as never before to critical examination. We have become more circumspect in our attitude towards natural "laws." We have attained to a clearer view of our working hypotheses—of their uses and their limitations. With the best of intentions

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

¹ Address of the President of the American Association for the Advancement of Science, Philadelphia, December 28, 1914.

we do not always succeed in keeping them clear of metaphysics, but at least we have learned to try. We perceive more and more clearly that science does not deal with ultimate problems or with final solutions. In order to live science must move. She attempts no more than to win successive points of vantage which may serve, one after another, as stepping stones to further progress. When these have played their part they are often left behind as the general advance proceeds.

In respect to the practical applications of science we have almost ceased to wonder at incredible prodigies of achievement; yet in some directions they retain a hold on our imagination that daily familiarity can not shake. Not in our time, at least, will the magnificent conquests of sanitary science and experimental medicine sink to the level of the commonplace. Science here renders her most direct and personal service to human welfare; and here in less direct ways she plays a part in the advance of our civilization that would have been inconceivable to our fathers. Popular writers delight to portray the naturalist as a kind of reanimated antediluvian, wandering aimlessly in a modern world where he plays the part of a harmless visionary; but what master of romance would have had the ingenuity to put into the head of his mythical naturalist a dream that the construction of the Panama Canal would turn upon our acquaintance with the natural history of the mosquito, or that the health and happiness of nations—nay, their advance in science, letters, and the arts—might depend measurably on the cultivation of our intimacy with the family lives of house-flies, fleas and creatures of still more dubious antecedents!

I

Fourteen years ago to-night it was my privilege to deliver an address before the

American Society of Naturalists, entitled "Aims and Methods of Study in Natural History,"² in which I indicated certain important changes that were then rapidly gathering headway in zoology. To-night I once more ask attention to this subject as viewed in the fuller light of the remarkable period of progress through which biology has since been passing. I will not try to range over the whole vast field of zoology or to catalogue its specific advances. I will only permit myself a few rather desultory reflections suggested by a retrospect upon the progress of the past twenty-five years. If my view is not fully rounded, if it is colored by a long standing habit of looking at biological phenomena through the eyes of an embryologist, I will make no apology for what I am not able to avoid. Let me remind you also at how many points the boundaries between this and other branches of biology have become obliterated. The traditional separation between zoology and botany, for instance, has lost all significance for such subjects as genetics or cytology. Again, the artificial boundary often set up between zoology and animal physiology has wholly disappeared, owing to the extension of experimental methods to morphology and of comparative methods to physiology. I trust therefore that our brethren in botany and physiology—perhaps I should include also those in psychology—will not take it amiss if I include them with us under the good, old-fashioned name of *naturalists*.

The sum and substance of biological inquiry may be embodied in two questions: What is the living organism, and how has it come to be? We often find it convenient to lay the emphasis on one or the other of these questions, but fundamentally they are inseparable. The existing animal bears

² SCIENCE, N. S., XIII., No. 314, January 4, 1901.

the indelible impress of its past; the extinct animal can be comprehended only in the light of the present. For instance, the paleontologist is most directly concerned with problems of the past, but at every step he is confronted by phenomena only to be comprehended through the study of organisms as they now are. Our main causal analysis of evolution must be carried out by experimental studies on existing forms. All this seems self-evident, yet the singular fact is that only in more recent years have students of evolution taken its truth fully to heart. And here lies the key to the modern movement in zoology of which I propose to speak.

I do not wish to dwell on matters of ancient history; but permit me a word concerning the conditions under which this movement first began to take definite shape as the nineteenth century drew towards its close. In the first three decades after the "Origin of Species" studies upon existing animals were largely dominated by efforts to reconstruct their history in the past. Many of us will recall with what ardor naturalists of the time threw themselves into this profoundly interesting task. Many of us afterwards turned to work of widely different type; but have our later interests, I wonder, been keener or more spontaneous than those awakened by the morphological-historical problems, some of them already half forgotten, which we then so eagerly tried to follow? I am disposed to doubt it. The enthusiasm of youth? No doubt, but something more, too. Efforts to solve those problems have in the past often failed; they no longer occupy a place of dominating importance; but they will continue so long as biology endures, because they are the offspring of an ineradicable historical instinct, and their achievement stands secure in the great body of solid fact

which they have built into the framework of our science. Says Poincaré:

The advance of science is not comparable to the changes of a city, where old edifices are pitilessly torn down to give place to new, but to the continuous evolution of zoologic types which develop ceaselessly and end by becoming unrecognizable to the common sight, but where an expert eye finds always traces of the prior work of the centuries past. One must not think then that the old-fashioned theories have been sterile and vain.

And after all, science impresses us by something more than the cold light of her latest facts and formulas. The drama of progress, whether displayed in the evolution of living things or in man's age-long struggle to comprehend the world of which he is a product, stirs the imagination by a warmer appeal. Without it we should miss something that we fain would keep—something, one may suspect, that has played an important part at the higher levels of scientific achievement.

I seem to have been caught unawares in the act of moralizing. If so, let it charitably be set down as an attempt to soften the hard fact that thirty years after the "Origin of Species" we found ourselves growing discontented with the existing methods and results of phylogenetic inquiry and with current explanations of evolution and adaptation. Almost as if by a pre-concerted plan, naturalists began to turn aside from historical problems in order to learn more of organisms as they now are. They began to ask themselves whether they had not been over-emphasizing the problems of evolution at the cost of those presented by life-processes everywhere before our eyes to-day. They awoke to the insufficiency of their traditional methods of observation and comparison and they turned more and more to the method by which all the great conquests of physico-chemical science had been achieved, that which undertakes the analysis of phenom-

ena by deliberate control of the conditions under which they take place—*the method of experiment*. Its steadily increasing importance is the most salient feature of the new zoology.

Experimental work in zoology is as old as zoology itself; nevertheless, the main movement in this direction belongs to the past two decades. I will make no attempt to trace its development; but let me try to suggest somewhat of its character and consequences by a few outlines of what took place in embryology.

The development of the egg has always cast a peculiar spell on the scientific imagination. As we follow it hour by hour in the living object we witness a spectacular exhibition that seems to bring us very close to the secrets of animal life. It awakens an irrepressible desire to look below the surface of the phenomena, to penetrate the mystery of development. The singular fact nevertheless is that during the phylogenetic period of embryological research this great problem, though always before our eyes, seemed almost to be forgotten in our preoccupation with purely historical questions—such as the origin of vertebrates or of annelids, the homologies of germ-layers, gill-slits or nephridia, and a hundred others of the same type. Now, these questions are and always will remain of great interest; but embryology, as at last we came to see, is but indirectly connected with historical problems of this type. The embryologist seeks first of all to attain to some understanding of development. It was therefore a notable event when, in the later eighties, a small group of embryologists headed by Wilhelm Roux turned away from the historical aspects of embryology and addressed themselves to experiments designed solely to throw light upon the mechanism of development. The full significance of this step first came home to

us in the early nineties with Driesch's memorable discovery that by a simple mechanical operation we can at will cause one egg to produce two, or even more than two, perfect embryos. I will not pause to inquire why this result should have seemed so revolutionary. It was as if the scales had fallen from our eyes. With almost a feeling of shock we took the measure of our ignorance and saw the whole problem of development reopened.

The immediate and most important result of this was to stimulate a great number of important objective investigations in embryology. But let me pause for a moment to point out that at nearly the same time a similar reawakening of interest in the experimental investigation of problems of the present became evident in many other directions—for example, in studies on growth and regeneration; on cytology and protozoology; on economic biology; on ecology, the behavior of animals and their reactions to stimuli; on heredity, variation and selection. The leaven was indeed at work in almost every field of zoology, and everywhere led to like results. It was a day of rapid obliteration of conventional boundary lines; of revolt from speculative systems towards the concrete and empirical methods of the laboratory; of general and far-reaching extension of experimental methods in our science.

But I will return to embryology. It may be doubted whether any period in the long history of this science has been more productive of varied and important discoveries than that which followed upon its adoption of experimental methods. In one direction the embryologist went forward to investigations that brought him into intimate relations with the physicist, the chemist, the pathologist and even the surgeon. A flood of light was thrown on the phenomena of development by studies on differen-

tiation, regeneration, transplantation and grafting; on the development of isolated blastomeres and of egg-fragments; on the symmetry and polarity of the egg; on the relations of development to mechanical, physical and chemical conditions in the environment; on isolated living cells and tissues, cultivated like microorganisms, outside the body *in vitro*; on fertilization, artificial parthenogenesis and the chemical physiology of development. In respect to the extension of our real knowledge these advances constitute an epoch-making gain to biological science. And yet these same researches afford a most interesting demonstration of how the remoter problems of science, like distant mountain-peaks, seem to recede before us even while our actual knowledge is rapidly advancing. Thirty years after Roux's pioneer researches we find ourselves constrained to admit that in spite of all that we have learned of development the egg has not yet yielded up its inmost secrets. I have referred to the admirable discovery of Driesch concerning the artificial production of twins. That brilliant leader of embryological research had in earlier years sought for an understanding of development along the lines of the mechanistic or physico-chemical analysis, assuming the egg to be essentially a physico-chemical machine. He now admitted his failure and, becoming at last convinced that the quest had from the first been hopeless, threw all his energies into an attempt to resuscitate the half extinct doctrines of vitalism and to found a new philosophy of the organism. Thus the embryologist, starting from a simple laboratory experiment, strayed further and further from his native land until he found himself at last quite outside the pale of science. He did not always return. Instead he sometimes made himself a new home—upon occasion even established him-

self in the honored occupancy of a university chair of philosophy!

The theme that is here suggested tempts me to a digression, because of the clear light in which it displays the attitude of modern biology towards the study of living things. It is impossible not to admire the keenness of analysis, and often the artistic refinement of skill (which so captivates us, for instance, in the work of M. Bergson) with which the neo-vitalistic writers have set forth their views. For my part, I am ready to go further, admitting freely that the position of these writers *may* at bottom be well grounded. At any rate it is well for us now and then to be rudely shaken out of the ruts of our accustomed modes of thought by a challenge that forces upon us the question whether we really expect our scalpels and microscopes, our salt-solutions, formulas and tables of statistics, to tell the whole story of living things. It is, of course, impossible for us to assert that they will. And yet the more we ponder the question the stronger grows our conviction that the "entelechies" and such-like agencies conjured forth by modern vitalism are as sterile for science as the final causes of an earlier philosophy; so that Bacon might have said of the former, as he did of the latter, that they are like the Vestal virgins—dedicated to God, and barren. We must not deal too severely with the naturalist who now and then permits himself an hour of dalliance with them. An uneasy conscience will sooner or later drive him back into his own straight and narrow way with the insistent query: The specific vital agents, *sui generis*, that are postulated by the vitalist—are they sober realities? Can the existence of an "élan vital," of "entelechies," of "psychoids" be experimentally verified? Even if beyond the reach of verification may they still be of prac-

tical use in our investigations on living things, or find their justification on larger grounds of scientific expediency. However philosophy may answer, science can find but one reply. *The scientific method is the mechanistic method.* The moment we swerve from it by a single step we set foot in a foreign land where a different idiom from ours is spoken. We have, it is true, no proof whatever of its final validity. We do not adopt the mechanistic view of organic nature as a dogma but only as a practical program of work, neither more nor less. We know full well that our present mechanistic conceptions of animals and plants have not yet made any approach to a complete solution of the problems of life, whether past or present. This should encourage us to fresh efforts, for just in the present inadequacy of these conceptions lies the assurance of our future progress. But the way of unverifiable (and irrefutable) imaginative constructions is not our way. We must hold fast to the method by which all the great advances in our knowledge of nature have been achieved. We shall make lasting progress only by plodding along the old, hard beaten trail blazed by our scientific fathers—the way of observation, comparison, experiment, analysis, synthesis, prediction, verification. If this seems a prosaic program we may learn otherwise from great discoverers in every field of science who have demonstrated how free is the play that it gives to the constructive imagination and even to the faculty of artistic creation.

II

Thus far I have desired to emphasize especially the reawakening of our interest in problems of the present, and the growing importance of experimental methods in our science. It is interesting to observe how these changes have affected our atti-

tude towards the historical problem as displayed in the modern study of genetics. Even here we are struck by the same shifting of the center of gravity that has been remarked in other fields of inquiry. In the Darwinian era studies on variation and heredity seemed significant mainly as a means of approach to the problems of evolution. The post-Darwinians awoke once more to the profound interest that lies in the genetic composition and capacities of living things as they now are. They turned aside from general theories of evolution and their deductive application to special problems of descent in order to take up objective experiments on variation and heredity for their own sake. This was not due to any doubts concerning the reality of evolution or to any lack of interest in its problems. It was a policy of masterly inactivity deliberately adopted; for further discussion concerning the causes of evolution had clearly become futile until a more adequate and critical view of existing genetic phenomena had been gained. Investigators in genetics here followed precisely the same impulse that had actuated the embryologists; and they, too, reaped a rich harvest of new discoveries. Foremost among them stands the re-discovery of Mendel's long-forgotten law of heredity—a biological achievement of the first rank which in the year 1900 suddenly illuminated the obscurity in which students of heredity had been groping. Another towering landmark of progress is De Vries's great work on the mutation theory, published a year later, which marked almost as great a transformation in our views of variation and displayed the whole evolution problem in a new light. In the era that followed, the study of heredity quickly became not only an experimental but almost an exact science, fairly comparable to chemistry in its systematic employment

of qualitative and quantitative analysis, synthesis, prediction and verification. More and more clearly it became evident that the phenomena of heredity are manifestations of definite mechanism in the living body. Microscopical studies on the germ-cells made known an important part of this mechanism and provided us with a simple mechanical explanation of Mendel's law. And suddenly in the midst of all this, by a kaleidoscopic turn, the fundamental problem of organic evolution crystallizes before our eyes into a new form that seems to turn all our previous conceptions topsy-turvy.

I will comment briefly on this latest view of evolution, partly because of its inherent interest, but also because it again exemplifies, as in the case of embryology, that temptation to wander off into metaphysics (*sit venia verbo!*) which seems so often to be engendered by new and telling discoveries in science. The fundamental question which it raises shows an interesting analogy to that encountered in the study of embryology, and may conveniently be approached from this side.

To judge by its external aspects, individual development, like evolution, would seem to proceed from the simple to the complex; but is this true when we consider its inner or essential nature? The egg *appears* to the eye far simpler than the adult; yet genetic experiment seems continually to accumulate evidence that for each independent hereditary trait of the adult the egg contains a corresponding *something* (we know not what) that grows, divides and is transmitted by cell-division without loss of its specific character and independently of other somethings of like order. Thus arises what I will call the puzzle of the microcosm. Is the appearance of simplicity in the egg illusory? Is the hen's egg fundamentally as complex

as the hen, and is development merely the transformation of one kind of complexity into another? Such is the ultimate question of ontogeny, which in one form or another has been debated by embryologists for more than two centuries. We still can not answer it. If we attempt to do so, each replies according to the dictates of his individual temperament—that is to say, he resorts to some kind of symbolism; and he still remains free to choose that particular form which he finds most convenient, provided it does not stand in the way of practical efforts to advance our real knowledge through observation and experiment. Those who must have everything reduced to hard and fast formulas will no doubt find this rather disconcerting; but worse is to follow. Genetic research now confronts us with essentially the same question as applied to the evolutionary germ. The puzzle of the microcosm has become that of the macrocosm. Were the primitive forms of life really simpler than their apparently more complex descendants? Has organic evolution been from the simple to the complex, or only from one kind of complexity to another? May it even have been from the complex to the simple by successive losses of inhibiting factors which, as they disappear, set free qualities previously held in check? The last of these is the startling question that the president of the British Association propounds in his recent brilliant address at Melbourne, asking us seriously to open our minds to the inquiry: "Whether evolution can at all reasonably be represented as an unpacking of an original complex which contained within itself the whole range of complexity which living things exhibit?" This conception, manifestly, is nearly akin to the theory of pangenesis and individual development, as elaborated especially by De Vries and by Weismann. It inevitably re-

calls also, if less directly, Bonnet's vision of "palingenesis," which dates from the eighteenth century.

We should be grateful to those who help us to open our minds; and Professor Bateson, as is his wont, performs this difficult operation in so large and masterly a fashion as to command our lively admiration. It must be said of his picturesque and vigorous discussion that we are kept guessing how far we are expected to take it seriously, or at least literally. We have always a lurking suspicion that possibly his main purpose may after all be to remind us, by an object lesson, how far we still are from comprehending the nature and causes of evolution, and this suspicion is strengthened by the explicit statement in a subsequent address, delivered at Sydney, that our knowledge of the nature of life is "altogether too slender to warrant speculation on these fundamental questions." Let us, however, assume that we are seriously asked to go further and to enter the *cul de sac* that Professor Bateson so invitingly places in our way. Once within it, evidently, we are stalemated in respect to the origin and early history of life; but as to that, one form of total ignorance is perhaps as good as another, and we can still work out how the game has been played, even though we can never find out how the pieces were set up. But has the day so soon arrived when we must resign ourselves to such an ending? Are we prepared to stake so much upon the correctness of a single hypothesis of allelomorphism and dominance? This hypothesis—that of "presence and absence"—has undoubtedly been a potent instrument of investigation; but there are some competent students of genetics who seem to find it equally simple to formulate and analyze the phenomena by the use of a quite different hypothesis, and one that involves no such paradoxical consequences in respect to the nature of

evolution. Are we not then invited to strain at a gnat and to swallow a camel?

But I pass over the technical basis of the conception in order to look more broadly at its theoretic superstructure. Is not this, once again, a kind of symbolism by which the endeavor is made to deal with a problem that is for the present out of our reach? Neither you nor I, I dare say, will hesitate to maintain that the primordial Amœba (if we may so dub the earliest of our ancestors) embodied in some sense or other all the potentialities, for better or for worse, that are realized before us at this moment in the American Association for the Advancement of Science. But if we ask ourselves exactly what we mean by this we discover our total inability to answer in more intelligible terms. We can not, it is true, even if we would, conquer the temptation now and then to spread the wings of our imagination in the thin atmosphere of these upper regions; and this is no doubt an excellent tonic for the cerebrum provided we cherish no illusions as to what we are about. No embryologist, for example, can help puzzling over what I have called the problem of the microcosm; but he should be perfectly well aware that in striving to picture to his imagination the organization of the egg, of the embryological germ, that is actually in his hands for observation and experiment, he is perilously near to the habitat of the mystic and the transcendentalist. The student of evolution is far over the frontier of that forbidden land, in any present attack upon the corresponding problem of the macrocosm; for the primordial Amœba, the evolutionary germ, is inconceivably far out of our reach, hidden behind the veil of a past whose beginnings lie wholly beyond our ken. And why, after all, should we as yet attempt the exploration of a region which still remains so barren and remote?

Surely not for the lack of accessible fields of genetic research that are fertile and varied enough to reward our best efforts, as no one has more forcibly urged or more brilliantly demonstrated by his own example than Professor Bateson himself.

Perhaps it would be the part of discretion to go no further. But the remarkable questions that Professor Bateson has raised concerning the nature of evolution leave almost untouched the equally momentous problem as to what has guided its actual course. In approaching my close I shall be bold enough to venture a step in this direction, even one that will bring us upon the hazardous ground of organic adaptations and the theory of natural selection. I need not say that this subject is beset by intricate and baffling difficulties which have made it a veritable bone of contention among naturalists in recent years. In our attempts to meet them we have gone to some curious extremes. On the one hand, some naturalists have in effect abandoned the problem, cutting the Gordian knot with the conclusion that the power of adaptation is something given with organization itself and as such offers a riddle that is for the present insoluble. In another direction we find attempts to take the problem in flank—to restate it, to ignore it—sometimes, it would almost seem to argue it out of existence. It has been urged in a recent valuable work—by an author, I hasten to say, who fully accepts both the mechanistic philosophy and the principle of selection—that fitness is a reciprocal relation, involving the environment no less than the organism. This is both a true and a suggestive thought; but does it not leave the naturalist floundering amid the same old quicksands? The historical problem with which he has to deal must be grappled at closer quarters. He is everywhere confronted with specific devices in the organ-

ism that must have arisen long after the conditions of environment to which they are adjusted. Animals that live in water are provided with gills. Were this all we could probably muddle along with the notion that gills are no more than lucky accidents. But we encounter a sticking point in the fact that gills are so often accompanied by a variety of ingenious devices, such as reservoirs, tubes, valves, pumps, strainers, scrubbing brushes and the like, that are obviously tributary to the main function of breathing. Given water, asks the naturalist, how has all this come into existence and been perfected? The question is an inevitable product of our common sense. The metaphysician, I think, is not he who asks but he who would suppress it.

For all that it would seem that some persons find the very word adaptation of too questionable a reputation for mention in polite scientific society. Allow me to illustrate by a leaf taken from my own notebook. I once ventured to publish a small experimental work on the movements of the freshwater Hydra with respect to light. What was my surprise to receive a reproof from a friendly critic, because I had not been content with an objective description of the movements but had also been so indiscreet as to emphasize their evident utility to the animal. I was no doubt too young then—I fear I am too old now—to comprehend in what respect I had sinned against the light. That was long ago. I will cite a more recent example from a public discussion on adaptation that took place before the American Society of Naturalists a year or two since. "The dominance of the concept of adaptation," said one naturalist, "which now distinguishes our science from the non-biological ones, is related to the comparatively youthful stage of development so far attained by biology, and *not to any observed character in the*

living objects with which we deal." Here we almost seem to catch an echo from the utterances of a certain sect of self-styled "scientists" who love to please themselves with the quaint fancy that physical disease is but one of the "errors of mortal mind."

Now, it is undoubtedly true that many adaptations, to cite Professor Bateson once more, are "not in practise a very close fit." Even the eye, as Helmholtz long ago taught us, has some defects as an optical instrument; nevertheless, it enables us to see well enough to discern some food for reflection concerning adaptations among living things. And it is my impression that efforts to explain adaptations are likely to continue for the reason that naturalists as a body, perhaps influenced by Huxley's definition of science, have an obstinate habit of clinging to their common sense.

At the present day there is no longer the smallest doubt of the great outstanding fact that many complex structural adaptations—it would probably be correct to say all such—have not come into existence at a single stroke but have moved forward step by step to the attainment of their full degree of perfection. What has dominated the direction and final outcome of such advancing lines? We can not yet answer this question with any degree of assurance; but procrastinate as we may it must in the end squarely be faced. We have seen one theory after another forced back within narrower lines or crumbling away before the adverse fire of criticism. I will not pause to recount the heavy losses that must be placed to the account of sexual selection, of neo-Lamarckism, of orthogenesis. Some naturalists, no doubt, would assign a prominent place in this list of casualties to natural selection; but probably there are none who would hold that it has been destroyed utterly. The crux lies in the degree

of its efficacy. Stated as an irreducible minimum the survival of the fit is an evident fact. Individuals that are unfitted to live, or to reproduce, leave few or no descendants—so much, at least, must be admitted by all. But does this colorless and trite conclusion end the matter or adequately place before us the significance of the facts? Just here lies the whole issue. Does destruction of the unfit accomplish no other result than to maintain the *status quo*, or has it conditioned the direction of progress? Accepting the second of these alternatives, Darwin went so far as to assign to it a leading rôle among the conditions to which the living world owes its existing configuration. Since his time the aspect of the problem has widely changed. We must rule out the question of the origin of neutral or useless traits. We must not confuse the evolution of adaptations with the origin of species. We must bear in mind the fact that Darwin often failed to distinguish between non-heritable fluctuations and hereditary mutations of small degree. We are now aware that many apparently new variations may be no more than recombination-products of preexisting elements. We should, no doubt, make a larger allowance for the rôle of single "lucky accidents" in evolution than did many of the earlier evolutionists. And yet, as far as the essence of the principle is concerned I am bound to make confession of my doubts whether any existing discussion of this problem affords more food for reflection, even to-day, than that contained in the sixth and seventh chapters of the "Origin of Species" and elsewhere in the works of Darwin.

Undeniably there is a large measure of truth in the contention that natural selection still belongs rather to the philosophy than to the science of biology. In spite of many important experimental and

critical studies on the subject Darwin's conception still remains to-day in the main what it was in his own time, a theory, a logical construction, based it is true on a multitude of facts, yet still awaiting adequate experimental test. Simple though the principle is, its actual effect in nature is determined by conditions that are too intricate and operate through periods too great to be duplicated in the experimental laboratory. Hence it is that even after more than fifty years of Darwinism the time has not yet come for a true estimate of Darwin's proposed solution of the great problem.

But there is still another word to be said. Too often in the past the facile formulas of natural selection have been made use of to carry us lightly over the surface of unsuspected depths that would richly have repaid serious exploration. In a healthy reaction from this purblind course we have made it the mode to minimize Darwin's theory; and no doubt a great service has been rendered to our study of this problem by the critical and sceptical spirit of modern experimental science. But there is a homely German saying that impresses upon us the need of caution as we empty out the bath lest we pour out the child too. This suggests that we should take heed how we underestimate the one really simple and intelligible explanation of organic adaptations, inadequate though it now may seem, that has thus far been placed in our hands. And in some minds—if I include my own among them let it be set down to that indiscretion at which I have hinted—the impression grows that our preoccupation with the problem as it appears at short focus may in some measure have dimmed our vision of larger outlines that must be viewed at longer range; that we may have emphasized minor difficulties at the cost of a larger truth. To such minds it will seem that the principle of natural selection,

while it may not provide a master key to all the riddles of evolution, still looms up as one of the great contributions of modern science to our understanding of nature.

I have taken but a passing glance at a vast and many-sided subject. I have tried to suggest that the tide of speculation in our science has far receded; that experimental methods have taken their rightful place of importance; that we have attained to a truer perspective of past and present in our study of the problems of animal life. The destructive phase through which we have passed has thoroughly cleared the ground for the new constructive era on which we now have entered. All the signs of the times indicate that this era will long endure. And this is of good augury for a future of productive effort, guided by the methods of physico-chemical science, impatient of merely *a priori* constructions, of academic discussions, of hypotheses that can not be brought to the test of experimental verification. The work ahead will make exacting technical demands upon us. The pioneer days of zoology are past. The naturalist of the future must be thoroughly trained in the methods and results of chemistry and physics. He must prepare himself for a life of intensive research, of high specialization; but in the future even more than in the past he will wander in vain amid the dry sands of special detail if the larger problems and general aims of his science be not held steadfastly in view. For these are the outstanding beacon lights of progress; and while science viewed at close range seems always to grow more complex, a wider vision shows that her signal discoveries are often singularly simple. This perhaps may help us to keep alive the spirit of the pioneers who led the advances of a simpler age; and it is full of hope for the future.

EDMUND B. WILSON

COLUMBIA UNIVERSITY

NATIONAL ACADEMIES AND THE PROGRESS OF RESEARCH. II**USES OF AN ACADEMY BUILDING**

In addition to experimental and illustrated lectures, the Academy might advantageously maintain exhibits freely open to the public, showing the current researches of its members, the most recent European advances in science, and new applications of scientific methods in the industries. It goes without saying that ample space and the best of facilities would be required for this purpose. If carefully worked out, this plan should provide an additional means of keeping the public informed of the progress of research and its bearing on the industries of the country. While emphasis should always be laid in such exhibits on pure science, which it is the Academy's prime object to advance, some of the most striking illustrations of the applications of science should also be introduced.

It is obvious that the Academy can not undertake such activities unless it can obtain a large building of its own. The advantages of having such a building for other purposes have already been touched upon. The attractiveness of the annual meetings would be greatly enhanced if they were held in such surroundings as an Academy building could supply. There is a very real difference between the atmosphere of bare halls, casually occupied, and attractively furnished rooms, permanently belonging to the Academy, and charged with the stimulating traditions accumulated during the process of time. The walls should be hung with portraits of past presidents and other eminent men of science, which could easily be obtained if there were a place for them. Moreover, the example of the Royal Society in preserving Newton's telescope and of the Royal Institution in exhibiting the original instruments of Davy, Faraday and other

great investigators, should be followed as soon as possible by the National Academy. Doubtless it is still feasible to secure instruments used by Joseph Henry, the two Agassizs, and others who have played a similar part in the history of the Academy. A permanent committee, charged with the collection of portraits, manuscripts, and instruments, and exercising care and discrimination in its selections, would gradually bring together many objects which would become more and more valuable with the passage of time.¹⁸

HISTORICAL EXHIBITS

[Few writers on civilization in America appreciate how largely the United States has contributed to the development of certain fields of research. The mathematical memoirs of Gibbs were of fundamental importance, while in such fields as celestial mechanics, practical astronomy, astrophysics, experimental physics, geology and paleontology, and in many of the newer phases of biology and experimental medicine, National Academy members have led the way in a long series of advances. An exhibit of original instruments, manuscripts, and photographs, arranged so as to show the successive contributions of American investigators in various departments of research, would prove an inspiration to many a young and enthusiastic aspirant to the pleasures of original discovery. I shall never forget my own delight in first seeing some of Henry Draper's original negatives of stellar spectra. Many of these are now in the possession of the Academy, ready for use in an exhibit of continuous progress in astronomical spectroscopy covering the

¹⁸ [A committee of this kind, which was appointed in November, 1913, has already received from Mrs. Henry Draper valuable instruments and original negatives illustrating the pioneer researches in astrophysics of the late Henry Draper.]

whole history of the Academy: Rutherford's first successful diffraction gratings and large-scale photographs of the solar spectrum; Draper's spectra of stars and planets, the first to show the lines; Young's pioneer observations of the spectra of sun-spots and the chromosphere; Langley's bolometric investigations in the invisible region of the infra-red, and his measures of the solar constant of radiation; Pickering's extensive discoveries and classification of stellar spectra photographed with the objective prism; Rowland's invention of the concave grating, and his fundamental studies of solar and laboratory spectra; Michelson's ingenious and varied contributions to the instruments of spectroscopy, comprising the interferometer, echelon and large grating, and his researches with them; Keeler's studies of celestial spectra, inaugurating the era of accurate radial velocity measurements; Campbell's perfection of the stellar spectrograph and the far-reaching results of his years of observation. Each of these American investigators marked a distinct epoch in astrophysical research, and their labors form a continuous chain covering the entire life of their subject. It is still possible to obtain many of their original instruments and earliest photographs, and to exhibit them in an attractive manner. Who would not like to see an actual spectrum formed by Rowland's earliest grating? A touch of a button operating an arc light mounted before the spectroscope slit, is all that would be necessary. And if this can be done in one field of research, there is no reason why similar stimulus can not be given in others, though of course in varying degree. If many subjects can show any such series of advances as we have seen in astronomical spectroscopy, the pessimism shown by some writers regarding American research must surely give way to optimism. And no

method of bringing the true state of affairs to easy comprehension, both to men of science and to the public, could equal that of the proposed exhibit. It goes without saying that the ingenious and attractive devices of modern museums should be employed, instead of the dry and forbidding exhibition methods of former times.]

The committee on historical apparatus might also have charge of instruments belonging to the various trust funds and no longer in use by the persons to whom the original grants for their purchase were made. In the course of time such a collection would naturally grow to considerable proportions, and the Academy would be enabled to assist its members by the loan of these instruments, as the Royal Society has done so effectively. The objection which is sometimes made to the purchase of standard instruments by the recipients of grants would thus be removed, as such instruments might prove of great service in a collection for general use.

TENTATIVE DESIGN OF AN ACADEMY BUILDING

[The design of an Academy building here reproduced¹⁹ is intended merely as a

¹⁹ [From preliminary sketches by the firm of Shepley, Rutan and Coolidge. Some of the designations of rooms here employed should be modified. The name "conversazione room" for the large public hall comes from the annual conversazioni of the Royal Society, where many instruments and experimental exhibits are shown. The photographic room (not needed on this floor) should be used for council meetings, setting free the room allotted in the plan to the council for a members' ante-room, adjoining the meeting room. The meeting, lecture and exhibition halls are shown in Fig. 2 as extending up through the second floor, but the laboratories and other parts of the building would be divided into several stories of ordinary height. The laboratories may of course be devoted to any desired field of research, and the designations are merely intended to suggest that one of these be in the physical and the other in the biological sciences.]

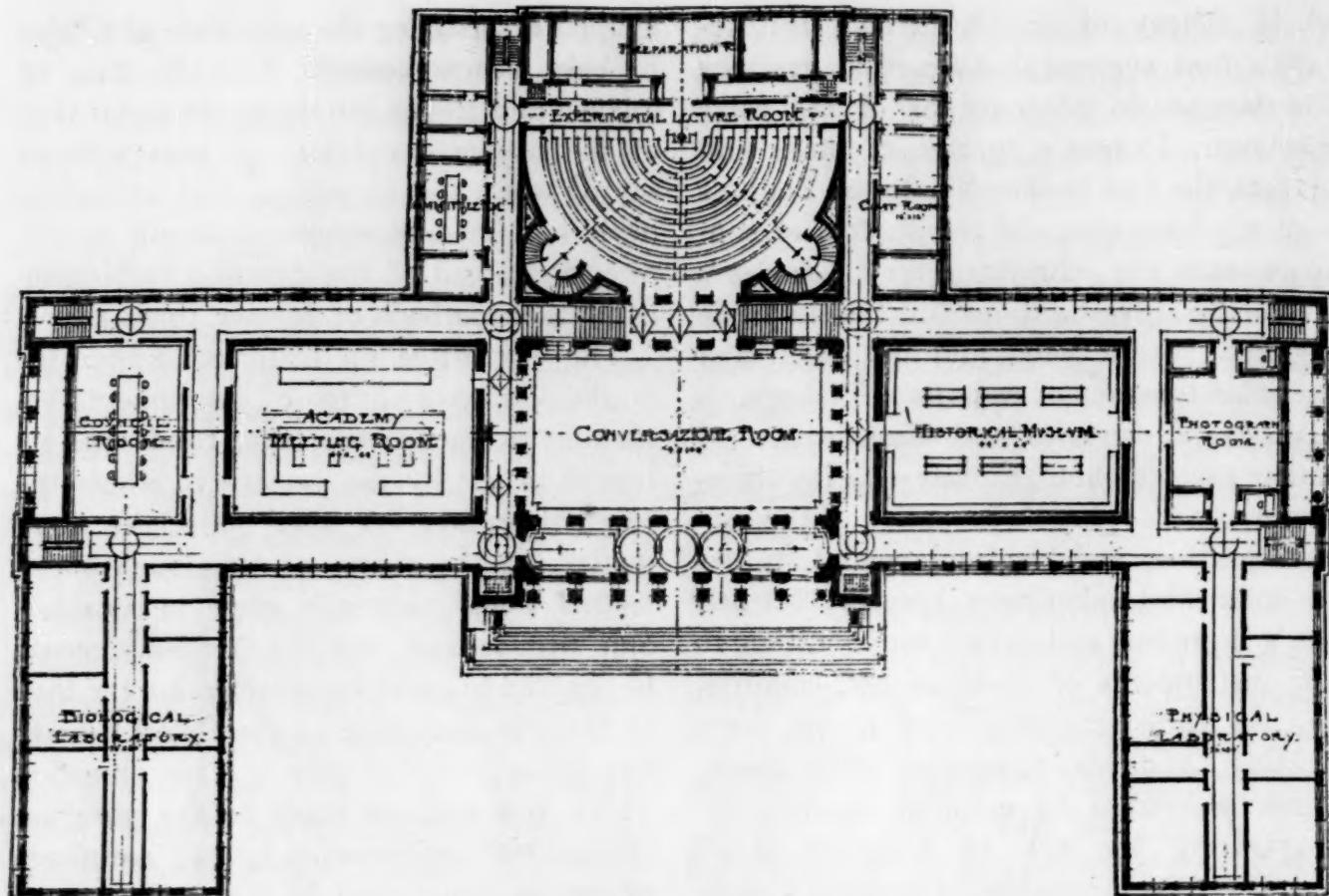


FIG. 1.

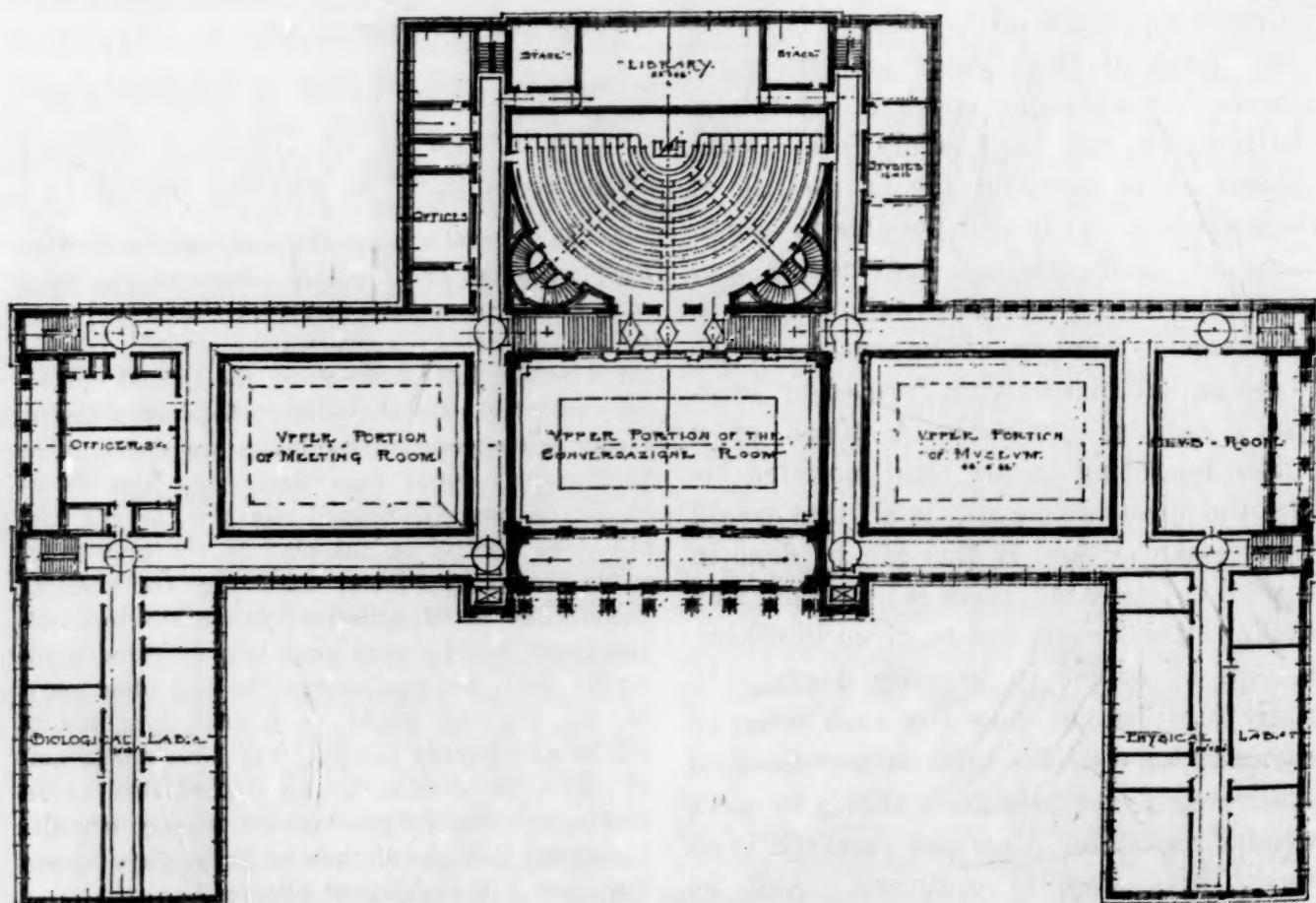


FIG. 2.

basis for discussion. The large public hall into which the main entrance leads is for the proposed exhibit of current research, illustrating the latest advances in pure and applied science, both American and foreign. The public would undoubtedly appreciate an opportunity to see under microscopes the most recently discovered bacilli, and to examine specimens illustrating the experimental variation of plants or animals, photographs showing new astronomical discoveries, experimental demonstrations of physical phenomena like the recently found Stark effect (the influence of an electric field on radiation), the structure of crystals, X-ray spectra and their bearing on the constitution of the atom, etc. As the home of such an exhibit, and the place of publication of the *Proceedings*, announcing the current advances of American research, the Academy would soon be recognized in its true character as the natural center and promoter of the scientific work of the United States.

In the adjoining room to the right the exhibit of historical research would connect the present with the past, and give a clear picture of American progress in the field of science. The possibilities of this exhibit have already been mentioned, but it may be remarked here that one of its prime purposes should be to stimulate further investigation and to aid in the Academy's work of correlating science by indicating converging lines of research. Both of these objects are of course perfectly compatible with the initial idea of commemorating the labors of Academy members.

The lecture hall at the rear of the building completes the group of rooms open to the public. This should embody some of the features which make the lecture hall of the Royal Institution so attractive. The provision of ample facilities for experi-

mental demonstrations (including a well-equipped preparation room) which no large lecture hall in Washington contains at present, would add greatly to the means of interesting both men of science and the public.

To the left of the central hall is the Academy meeting room, which might advantageously combine various features found in European academies. One of the most attractive meeting rooms abroad is that of the Paris Academy of Sciences. The provision of a comfortable ante-room,²⁰ equipped like a club and providing abundant opportunity for conversation among members, would be a valuable addition. Instead of admitting visitors to the meeting-room they could be better accommodated in a second floor gallery, above the ante-room, similar to the visitors' gallery of the Amsterdam Academy. Finally, a modified seating arrangement (probably retaining the tables for officers and members) would permit the inclusion of a screen and experiment table at one end of the room.

The main floor would also contain a council room,²¹ and various offices, cloak rooms, serving rooms, apparatus rooms, etc., needed for use in connection with meetings, lectures, exhibits, public receptions and other functions. The offices of the secretaries, editorial rooms, library and reading rooms, private research rooms and other rooms not for public purposes would be on the floors above. The example of the Berlin Academy,²² which provides numerous offices (45 in all) in its new building for the compilation of data required for a general catalogue of stars, bodies of

²⁰ In the space here marked "Council Room."

²¹ In the space here marked "Photograph Room."

²² See "The Work of European Academies," SCIENCE, November 14, 1913, p. 692.

Greek and Latin inscriptions, a great Egyptian dictionary, and other similar undertakings, might well be imitated here. For instance, it would have been of great advantage to the Academy if it had been able to furnish Professor Newcomb with offices for the computers employed in his extensive astronomical researches, during the active period which followed his retirement from the Nautical Almanac office. Small study rooms for members staying in Washington, engaged in writing or research involving the use of the Academy library, would also be useful.

The two wings shown to the right and left of the main building are intended for research laboratories. While the great majority of members seem to favor the inclusion of such laboratories in the Academy's scheme of development, there are a few who do not, and it is desirable to point out why they appear desirable. The Academy stands, first and foremost, for research, which it seeks to advance in every effective way. It may thus follow the example of various academies abroad, such as St. Petersburg, which carries on important researches in physics and other subjects; Stockholm, which has long provided in its own laboratories for the spectroscopic investigations of Hasselberg; and Berlin, which has produced the extensive investigations already enumerated. Nothing could do more to advance the Academy's influence on the progress of science than the production of important results from its own laboratories. But there is another and even stronger argument in favor of their establishment.

It has been well said by one who has studied the problems of the Academy, that the success of its future work must depend upon the discovery of men who are willing and able to devote the necessary time and energy to it. Two Academy members, in

commenting on suggestions for a building, remark that not laboratories, but *men* are needed. Those who are familiar with the history of the Academy are aware of the great amount of unselfish effort which it owes to its officers and members. But the fact remains that a man's first allegiance is to the university or other institution which counts him on its staff. As long as he retains such connections he can devote only his spare time to the work of the Academy, which, nevertheless, demands his best efforts.

The provision of research laboratories, with funds for their maintenance, would enable the Academy to command the entire time and effort of some of the ablest men in the country. The growing work, which already throws heavier burdens than the members realize on the willing shoulders of the Home Secretary, may later demand (as in the Royal Society) the services of two men, one representing the mathematical and physical, the other the biological sciences. The only way to secure the undivided service of such men is to offer them adequate salaries, a suitable staff of assistants, and ample laboratory facilities. Thus, while carrying on their researches in the name of the Academy, they would be able to direct the extensive work which the exhibits of current and historical research, the publication of the *Proceedings* and other contemplated activities must involve. Their position would be much like that of Faraday at the Royal Institution, with added duties defined by the broader range of the Academy's field.

An important object of the proposed research laboratories, therefore, is to attract and hold the men whose unrestricted time and energy the Academy urgently needs. Volunteer service will continue and multiply, but it can never hope to accomplish all that the future will require.

No details of laboratory design need be discussed here. The use of the unit system of rooms, exemplified in the Harvard Medical School, would eliminate many difficulties, and facilitate alterations to meet changing needs. A common plant of refrigerating machinery, compression pumps, constant-temperature rooms and other requirements of both laboratories, could be placed on the ground floor of the main building, which would also contain rooms for storing reserve Academy publications and for other miscellaneous purposes.

Enough has been said to indicate some of the possible uses of an Academy building, and the corresponding necessities of the design. The present plan, which is merely tentative, may serve to bring out criticisms and suggestions from members, who will undoubtedly think of many advantageous modifications. A classic treatment is indicated, but this is mainly because of the prevailing conditions in Washington, and the probability that a government site could not be obtained for a building of collegiate Gothic design, for example.

It would be advantageous for the Academy to appoint a strong committee, representing all branches of science, to design a suitable building. Much time and thought are necessary to secure a satisfactory plan, which will provide for present needs, and be readily adaptable to future developments. As for funds, some time may be required to find the sum needed, but the opportunity is such an exceptional one that a willing donor is sure to appear in the future. The only way to obtain gifts for building or endowment is to have a scheme so promising, and plans so attractive as to convince a prospective investor that his funds will be effectively used. Notable cases might be cited where large gifts followed the presentation of effective building designs, which appealed

not only to the eye, but equally to the judgment of the donor.]

TRUST FUNDS

The trust funds of the Academy, as shown in a previous article, have a total of over eighty thousand dollars, the income of which is exclusively devoted to research. In addition, there are other funds totaling over thirty-six thousand dollars, primarily intended for the endowment of medals and prizes, which enjoy a considerable surplus income also available for original investigation. By these means the Academy has been able to assist many of the most important researches of American science. A closer connection between the various committees, and the adoption of a concerted plan of action, would perhaps increase still further the usefulness of the funds. As a committee charged with the study of the use of trust funds has admirably expressed it:

The Academy should take the initiative in the organization and conduct of research. It should not wait for applications or for suggestions to come in wholly from the outside. Such suggestions should be urged, but the Academy should not relegate itself to the function of a mere disbursing organization; it should seek rather to determine what projects are worthy of investigation and how the funds may be most judiciously administered.

Such a policy would seem to imply a careful examination on the part of each committee of the existing conditions and needs of research in its own field, and an endeavor, through cooperation with the other committees, to secure a well-balanced and thoroughly effective use of all Academy funds available for investigation. As already suggested, the gradual accumulation of instruments, returned on the completion of the work for which they were purchased, should ultimately result in a marked gain in the efficiency of the funds.

and in the Academy's ability to assist investigators.

[As a body which is rapidly becoming truly representative of the investigators of America, the National Academy is well qualified to act in an advisory capacity to other institutions having funds available for use in research. It frequently happens that trustees of funds thus applicable require such expert advice as the Academy can give. A parallel case is that of the Royal Society, which selects annually the recipients of the Government Grant Fund of £4,000.

MEDALS AND PRIZES

In bestowing the Academy's gold medals for investigations in physics, astronomy, astrophysics, oceanography and the study of meteoric bodies, an attempt should be made, not only to recognize and reward successful investigators, but to do this in accordance with the best interests of future research. A few of the numerous medals awarded by academies, such as the Copley Medal of the Royal Society, may be advantageously reserved as a fitting recognition of many years of eminent service to science. But, as Diels²³ has justly remarked, the majority of medals and prizes will prove of greater value if given to comparatively young men, who still need support and encouragement. By acquaintance with the circumstances under which such men are working, an award may be made at a moment so favorable as to increase its value many fold. Thus recognition by the Academy may supply the precise argument needed to convince university authorities or others in control of research funds of the importance of providing the means necessary to continue and extend the work of the medallist. The same may be said

²³ "Die Kultur der Gegenwart," Teil I., Abteilung I., zweite Auflage, p. 666.

of grants from trust funds. Cases are known in which a comparatively small grant has favorably influenced a board of trustees in deciding to devote large sums to research.

This leads to a consideration of the question of membership in the National Academy. In his valuable discussion of the organization of science, to which reference has already been made, Professor Diels lays great emphasis upon the importance of aiding and encouraging the younger men of science through the award of grants for investigation. That this feeling is general throughout the German academies is shown by the fact that approximately one half of their resources are used for this purpose. Diels also finds cause for congratulation in the fact that the papers of these non-academics, published in the proceedings, often prove to be the most brilliant of Germany's contributions to science, and at the same time greatly aid in enlivening the work of the Academies.²⁴

Nothing could point more clearly to the best field of usefulness of our own National Academy. As the future of research depends directly upon the younger men, the Academy may properly devote a large share of its efforts to their support and advancement. But moral encouragement is no less important than financial aid. The latter may well be given from the trust funds of the Academy, but the former should not be neglected. The Academy does grant medals, but these are available in only a few fields of research.²⁵ Fortunately it also possesses a still more powerful resource in its opportunity to be-

²⁴ Diels, *ibid.*, p. 665.

²⁵ An attempt should be made to secure medals (or preferably money prizes available for the purchase of books or instruments) for mathematics, engineering, chemistry, geology, and the various branches of biology.

stow all the advantages and privileges of actual membership.

MEMBERSHIP

The great European academies differ among themselves in many particulars, most of all as regards membership. At one extreme we find the St. Petersburg Academy, with a president, a director and fifteen members, who are paid good salaries and provided with dwelling houses and laboratory facilities. At the other extreme stands the Royal Society, with 477 members, who receive no salaries or other tangible benefits. The other leading academies, such as Berlin, Paris, Rome and Vienna, lie between these limits.²⁶

The large membership of the Royal Society probably reflects, in some degree, the strongly democratic tendencies of England. But the working body of scientific investigators is sufficiently large to prevent the distinction of election to this venerable society from being impaired. In fact, on account of the great pains taken by the Council to inquire into the qualifications of the fifteen Fellows elected annually, the significance of the coveted title of F.R.S. is perhaps even greater to-day than at any earlier period in the history of the Society.

It can hardly be doubted that investigators of real ability are quite as numerous in the United States as in England. The available statistics indeed indicate that a much greater number of men are engaged here in research. The conditions are thus very different from those existing in 1863, when the National Academy was founded, with 50 members as its limiting number. Since 1906, when the maximum number of members elected annually was increased from five to ten, there has been a very perceptible change in the spirit of the Acad-

emy. By taking in a larger proportion of the younger men actively engaged in research, the Academy has increased its contact with living issues, and made itself more truly representative of American science. For the present, the election of ten new members annually may suffice, but I believe that the time will soon come when the limit should be raised from ten to fifteen.

It can not be gainsaid that a large number of able American investigators, who in England would certainly be elected to membership in the Royal Society, are still outside of our National Academy. The reason for this lies partly in the limit imposed on membership, and partly in the method of nomination, which seems to me susceptible of improvement. One difficulty, which will certainly increase in the future, has come about through the development of new fields of research. A man classed as a mathematician or an astronomer, both of which subjects are well represented in the Academy, is sure to receive consideration when nominations are being made. But if his subject be a comparatively new one, not represented among the nominating sections included in the existing classification of the Academy, his claims to recognition will be much less likely to command due attention. The constitution provides that the Council may nominate new members, but this privilege is exercised only in rare cases, and in any event there are certain disadvantages in this procedure. I trust that some means can be found of improving the system of nominations so as to overcome this difficulty, which now deprives the Academy of valuable members.²⁷

As for the qualifications of membership, it can hardly be doubted that the original plan of basing selections solely on the original contributions to science of the candidates should always be maintained. While

²⁶ See "The Work of European Academies," SCIENCE, 38, 686 et seq., 1913.

²⁷ [A committee is now at work on this subject.]

it is true that eminent administrators and others who exercise large influence in the intellectual world might prove to be of great service as members of the Academy, a wide departure from this fundamental principle would soon detract from the standing of the Academy as the national representative of original research. Thus while eminent services to the public should by no means be excluded from the field of the Academy's interests, and may well be recognized by the award of special medals founded for this purpose, actual membership should be confined to original investigators.

SCOPE OF THE ACADEMY

Here we may inquire as to the true scope of the Academy's work. In what degree should it confine its choice of members to the physical and natural sciences, and in what measure may it recognize successful research in such fields as philosophy, archeology, political economy, and history? The answer to this question will depend in part upon one's opinion of the chief object of the Academy. There are those who feel that the most important function of the National Academy is to confer distinction by election to membership. If this were its prime object, the participation of the members in the work of the Academy would be a minor matter, and any one of sufficient reputation as an investigator might be chosen. But if we agree, as I think the large majority will, that the Academy should be looked upon as a working body, and that its privilege of conferring distinction by election to membership is only one of many important functions, it seems to me that a means of defining our choice of investigators in the humanities may easily be found.

A single philologist, or a single political economist, may find but little of interest to

himself in the proceedings of a body made up almost exclusively of representatives of the physical and natural sciences. If so, he may not attend the meetings, and his membership would then serve merely as a mark of distinction. Deferring for a moment the discussion of the broad question whether the Academy should ever be reorganized in two or more large classes, after the manner of the Berlin Academy, it seems to me that we should augment the value of election by furnishing real reason to every member for participation in the work of the Academy. For example, in its committee on anthropology and psychology the National Academy now has three members engaged in the study of archeological problems. Although their work relates primarily to American ethnology, it differs in no essential respect from that of the classical archeologist or the student of Egyptology or Assyriology. Would it not be advisable, therefore, when the Academy chooses its next member from outside the domain of the physical and natural sciences, to elect an archeologist from one of these fields? If this were done he might be expected to take a more active interest in the work of the Academy, which would benefit by his contributions to its proceedings.²⁸

The advantages which might result from a wider extension of the scope of the National Academy raise the question whether an organization resembling that of the Berlin Academy will ever become desirable. This problem was long and seriously discussed by the Royal Society, and the negative decision of its deliberations led to the establishment of the British Academy. In spite of this decision, some of its leading

²⁸ William Dwight Whitney and William James resigned from the Academy, probably because they were the sole representatives of their subjects.

Fellows still believe that the Royal Society should have made room for a larger body of philosophers, historians and philologists than it now contains. Both the Royal Society and the National Academy have wisely refused to limit their membership to the physical and natural sciences. Such historians as Bryce and Morley and such Egyptologists as Petrie are now counted among the Fellows of the Royal Society, and Weld states that 116 archeological papers were published in the *Philosophical Transactions* before 1848.²⁹ But the large proportion of Fellows concerned with the physical and natural sciences, and the failure of the Society to recognize the philosophical-historical group in its organization, has prevented the Royal Society from taking part in the Section of Letters of the International Association of Academies, where the British Academy now represents England.

The National Academy, as a member of the Section of Science of the International Association, is in a position to secure adequate representation in foreign affairs of American interests in the natural sciences. The United States are also entitled to representation in the Section of Letters, but the present organization of the National Academy and the absence of a national body similar to the British Academy,³⁰ still leaves a vacancy there.

In my opinion it would not be advisable, under present conditions, to reorganize the National Academy on the model of the Berlin Academy. But I am heartily in sympathy with the idea of widening its scope and its field of interests, in some such way as that indicated above. This plan would permit the Academy to honor able

²⁹ "History of the Royal Society," Vol. 2, p. 565.

³⁰ The National Institute of Arts and Letters occupies a different field.

investigators outside of the physical and natural sciences, and at the same time gradually to build up small groups of these members who would aid the Academy in the development of its work. Ultimately the Academy might extend this phase of its activities sufficiently to secure representation in the Section of Letters of the International Association of Academies.

LOCAL ACADEMIES

A subject to which I have devoted special attention in the study of the problems of the National Academy, is its relationship to the various local academies which are widely distributed over the United States. These societies are of the greatest importance in the further development of American research, and the cultivation of an intelligent interest in the problems of science. Some of them have grown to such large proportions and established such excellent organizations that they need no assistance or encouragement from the National Academy. But after these exceptional societies have been excluded, there remain a great number of others, which the National Academy ought to be in a position to assist in various ways.

In an early period of its history, the Paris Academy of Sciences established close official relations with certain provincial academies in various parts of France. In fact, the Society of Montpellier is described in its royal letters patent as "an extension and a part" of the Paris Academy of Sciences.³¹ But a general plan of federation between the provincial academies and the Institute of France, such as that described by Bouillier in the work just cited, has never been carried into effect, and the old official relations have been discontinued. After careful consideration of Bouillier's

³¹ Bouillier, "L'Institut et les Académies de Province," p. 70.

plan, I doubt whether it could be advantageously applied in the United States under existing conditions.

This conclusion, however, does not mean that the National Academy can not be of service to local organizations. I believe, on the contrary, that it might find many ways and means of aiding them. The prime object is to secure a high standard of accomplishment among the minor academies remote from the chief centers of research, and to give the encouragement which the production of good work under unfavorable conditions so richly deserves. It should be possible to discover methods of realizing these ends, and thus to contribute to the strength and standing of the local academies and the progress of American research.

[It will be noticed that comparatively little attention has been given in this paper to the relationship of the Academy to the national government. This is due to no underestimate of the importance of the connection, but rather to the strong desire that this chief implication of the Academy's charter should ultimately be realized in the fullest sense. Valuable suggestions for cooperation with various departments of the government have been made by Academy members, and every effort should be exerted to carry them into effect. But recent experience indicates that the most promising way to accomplish this lies in first developing the standing and prestige of the Academy. When it becomes more widely and favorably known for its contributions to scientific progress, and is universally recognized as the national and authoritative representative of American science, the Academy's influence with Congress and with the various officers of the government will be far more potent than at present. I therefore believe that no effort should be made to press a demand for

greater government recognition until the publication of the *Proceedings* and other new activities have had time to produce their anticipated effect.]

In summarizing the suggestions offered in this paper, we see that many of the new activities proposed for the National Academy can not be undertaken without a suitable building. If this can be obtained, and adequately endowed, the Academy will be able greatly to extend its influence and usefulness both at home and abroad, through original researches, increased service to members, public lectures and exhibits, and greater cooperation in international projects. Under present conditions, the International Association of Academies could hardly be invited to meet in Washington. But if established in a home of its own, the Academy might ultimately succeed the Royal Society and the Academies of Paris, Rome, St. Petersburg and Berlin as the leading Academy of the Association for a period of three years. In this position it could contribute in a more effective way to the furtherance of international science, and to the study of the great problems of cooperative research, which offer large possibilities of extension and development.³²

The one way to secure a building and endowment is to prove by continual increase of efficiency that the Academy can use them to advantage. The establishment of *Proceedings*, the institution of lecture courses, the encouragement of broader methods of science teaching, and closer identification with the general interests of science as represented in all movements for the promotion of research and the diffusion of scientific knowledge, are opportunities open to immediate realization, and deserving of

³² I hope to discuss the international relations of the Academy in a future article.

the most careful consideration by the Academy. **GEORGE ELLERY HALE**
MOUNT WILSON
SOLAR OBSERVATORY

SCIENTIFIC NOTES AND NEWS

THE sixty-sixth meeting of the American Association for the Advancement of Science, in conjunction with a large number of national scientific societies is meeting in Philadelphia, as we go to press, under the presidency of Dr. Charles W. Eliot, of Harvard University. The address of the retiring president, Dr. Edmund B. Wilson, of Columbia University, is printed in the current issue of *SCIENCE*. We hope to print next week an account of the meeting to be followed by the more important addresses and papers and accounts of the proceedings of the section of the association and of the national societies.

DR. C. S. SHERRINGTON has been elected Fullerian professor of physiology at the Royal Institution for a term of three years, the appointment to date from January 13, 1915.

AT the annual meeting and election of the Academy of Natural Sciences, held on December 15, the following were elected: *President*, Dr. Samuel G. Dixon; *vice-presidents*, Edwin G. Conklin, Ph.D., and John Cadwalader; *recording secretary and librarian*, Dr. Edward J. Nolan; *corresponding secretary*, J. Percy Moore, Ph.D.; *treasurer*, George Vaux, Jr.; *curators*, Dr. Samuel G. Dixon, Henry A. Pilsbry, Dr. Witmer Stone and Dr. Henry Tucker; *councilors*, Charles B. Penrose, Charles Morris, Spencer Trotter and William E. Hughes.

DR. LOUIS SCHAPIRO, of Milwaukee, has accepted an appointment on the International Health Commission of the Rockefeller Foundation. After traveling through the southern states with other members of the commission, Dr. Schapiro will go to Costa Rica. After initiating work in the eradication of intestinal parasites, he will leave it in charge of local physicians and then probably will take charge of the work in northern Egypt.

R. D. HETZEL, director of extension for the Oregon Agricultural College, has been appointed chairman of the extension section of the American Association of Agricultural Colleges and Experiment Stations for the coming year.

SIR ERNEST and Lady Rutherford and Miss Eileen Rutherford spent a week in Montreal on their way home from New Zealand. Sir Ernest addressed the Physical and Chemical Societies of McGill University at a joint meeting on December 23, on "The Spectrum of X-rays and γ -rays."

FOR the purpose of studying the art, history and ethnology of China at close range, an expedition soon will be sent abroad by the University of Pennsylvania Museum, under the direction of C. W. Bishop, who has been curator since last June. His appointment was made with the idea of his leading this expedition. Mr. Bishop will first study Chinese art collections in the ancient cities of Japan, at Nikko, Nara and Kioto, where the temples and palaces contain some of the finest specimens in the world. He will then proceed to China, and his first explorations will cover a year of preliminary work. Special attention will be given to the art and ethnology of the Shans, Lulos and Miotses, which are remnants of the primitive tribes before the Chinese invasion.

DR. SIMON R. KLEIN, formerly professor of histology and embryology in Fordham University School of Medicine, New York City, has been appointed pathologist of the Norwich State Hospital for the Insane.

THE professors of chemistry of The Ohio State University gave a complimentary dinner on December 18 to Mr. John J. Miller, who is retiring from the editorship of *Chemical Abstracts*.

THE natural history department of the British Museum has the following men serving at the front in the war: Captain E. E. Austen (Diptera), with the 28th County of London Regt. (Artists Rifles); private K. G. Blair (Coleoptera), with the 4th Battalion Seaforth Highlanders; Lieutenant N. D. Riley (Lepi-

doptera), with the Army Service Corps; private C. Court Treatt (Birds), with the 28th City of London; private A. K. Totton (sponges, etc.), with the 28th City of London; Lieutenant Campbell-Smith (Mineralogy), with the 28th City of London. There are also many assistants serving; for example, nine from the department of zoology. All were unwounded as recently as December 4. Many of the museum staff who are unable to go into active service have been formed into a detachment of the Red Cross Society.

PROFESSOR WILLIAM M. CAMPBELL, of the department of physics of New York University, has resigned to take the position of president of the American Savings Bank.

E. D. SANDERSON, dean of the college of agriculture and director of the West Virginia agricultural experiment station, of West Virginia University, has resigned, to take effect on September 1. It is stated that he expects to pursue graduate studies.

WALTER HARVEY WEED, mining geologist, has removed his offices and that of the *Copper Handbook*, of which he is editor and owner, to 29 Broadway, New York City.

DR. VICTOR C. VAUGHAN, of the University of Michigan, president of the American Medical Association, was the guest of the St. Louis Medical Society at its meeting on December 12, and addressed the members on "Professional Ideals." Dr. Abraham Jacobi, of New York, also delivered a short address.

A DISCUSSION on preventive inoculation was opened by Professor G. Sims Woodhead at a meeting of the Royal Sanitary Institute at 90, Buckingham Palace Road, on December 15. The chair was taken by Sir Shirley Murphy.

DR. JOSEPH T. ROTHROCK, general secretary of the Pennsylvania Forestry Association, at the annual meeting held on December 14 advocated the use of the forest reserve lands of this state as outing grounds for the training of young men in physical endurance.

PROFESSOR U. S. GRANT, of Northwestern University, Evanston, Ill., lectured on December 10 before the State Microscopical Society

of Illinois, in Chicago, upon "The preparation of rock and mineral sections and their structure."

SIR FREDERIC EVE, in his Bradshaw lecture before the Royal College of Surgeons of England on December 15, dealt with acute hemorrhagic pancreatitis and the etiology of chronic pancreatitis.

A MEETING of the John Morgan Memorial Committee of the Philadelphia Alumni Society, Medical Department, University of Pennsylvania, has been held to consider plans looking toward the erection of a suitable memorial which shall do honor to the man who is called the founder of medicine in the United States.

SAMUEL BENEDICT CHRISTY, professor of mining and metallurgy in the University of California and dean of the college of mining, died in Berkeley, California, on November 30, 1914, at the age of sixty-one years. A graduate of the University of California of 1874, he had been continuously a member of its faculty since that time. He was a pioneer in the development of the cyanide process for the treatment of refractory ores. The engineers whom he has trained hold positions of great importance all over the world. At one time there were more of his graduates in important positions in South Africa than from all the other American universities put together. In 1902 he was given the degree of Sc.D. by Columbia. The Hearst Memorial Mining Building, built by Mrs. Phoebe A. Hearst some years ago as a mining laboratory for the university at a cost of \$640,000, embodies Professor Christy's ideas as to equipment for mining and metallurgical instruction.

THE death is reported, in his sixty-second year, of Dr. John Nisbet, forestry adviser to the Scottish Board of Agriculture.

ACCORDING to the *Journal* of the American Medical Association the International Health Commission of the Rockefeller Foundation has established laboratory stations for the diagnosis and treatment of hookworm at Panama, La Chorrera and Bocas del Toro. The work

was organized by Dr. L. W. Hackett of the commission, and according to the *Canal Record*, October 28, out of the first thousand men, women and children reporting at the La Chorrera laboratory more than 700 were found to be harboring hookworm. An effort is being made to induce every inhabitant of this village of 4,000 to submit to examination for hookworm, and circulars in simple language have been distributed and house-to-house visits and investigations have been made. Treatment is free, but not compulsory, although the work is carried on at the request and with the co-operation of the Panama government, and pressure may be brought to bear to make the campaign a thorough one. The establishment of laboratories in Panama is in pursuance of the plan of the International Health Commission for a world-wide campaign of health work in countries requesting the cooperation of the commission. Panama was one of the first countries to invite assistance. Great Britain has already solicited cooperation in behalf of her tropical possessions and a French and Dutch colonial service and an oriental service are also under consideration.

"IN 20 years the reindeer industry has made the Eskimos of Alaska civilized and thrifty men," says the United States Bureau of Education in a bulletin just issued. The reindeer industry began in Alaska in 1892 when the Bureau of Education imported from Siberia 171 reindeer. The object of the importation, according to the bulletin, was to furnish a source of supply for food and clothing to the Eskimos in the vicinity of Bering Strait. This importation was continued until 1902, and a total of 1,280 reindeer were brought from Siberia. There are now 47,266 reindeer distributed among 62 herds, and 30,532 of these are owned by the natives. This industry has given to the Alaskan Eskimos not only food and clothing, but a means of transportation superior to dog teams. Instead of being nomadic hunters eking out a precarious existence on the vast untimbered lands of the Arctic coast region "the Eskimos," according to the Bureau's bulletin "Now have assured support and opportunity to acquire

wealth by the sale of meat and skins to the white men." The reindeer industry is carefully guarded. "No native is permitted to sell or otherwise dispose of a female reindeer to any person other than a native of Alaska." This is done, the bulletin states, "lest white men deprive the natives of their reindeer and destroy this great native industry which the Bureau of Education has in the last 20 years built up and fostered." The reindeer service is an integral part of the educational system of the Bureau of Education for northern and western Alaska. The district superintendents of schools are also superintendents of the reindeer service. Promising and ambitious young natives are selected by superintendents as apprentices in the reindeer service, receiving 6, 8 or 10 reindeer at the close of the first, second and third years, respectively, and 10 more at the close of the fourth year. Upon the satisfactory termination of his apprenticeship, the native becomes a herder and assumes entire charge of a herd.

UNIVERSITY AND EDUCATIONAL NEWS

MR. G. S. YUILL, a graduate of Aberdeen University, has made a gift of £4,000 to the university, the interest upon this amount to be applied in furthering the study of chemistry.

MRS. A. HOSMER, of Oakland, has presented to the University of California several thousand molluscan shells, selected from the museum of the late Henry Hemphill, who assembled the most notable museum of Pacific coast molluscan shells ever collected.

DR. GEORGE HERBERT EVANS, of San Francisco, has been appointed assistant clinical professor of medicine in the University of California Medical School.

MR. T. V. BARKER, fellow of Brasenose College, Oxford, has been appointed university lecturer in chemical crystallography, and Mr. A. G. Gibson, Christ Church, university lecturer in morbid anatomy.

THE chair of medicine and clinical medicine in the University of Edinburgh has become vacant through the retirement of Professor John Wyllie.

DISCUSSION AND CORRESPONDENCE

GONIONEMUS MURBACHII MAYER

THE following note may be of interest to those who, since the discovery of *G. murbachii* in the "Eel Pond" at Woods Hole in 1894, have observed its persistence during succeeding summers at the original locality and have noted its rare occurrence elsewhere along the Sound.

According to Mayer¹ this medusa has been found occasionally in Woods Hole Harbor and has been reported from Noank, Connecticut and from Hadley Harbor, Muskegat (Muskeget) Island.

In the summer of 1911 while collecting zoological material at Groton, Conn., I found *G. murbachii* in abundance at Pine Island, off Avery Point, near the mouth of Poquonock River. This locality is five miles west of Noank. The little animals were common during the month of July and could usually be collected almost any time of the day by disturbing the rockweed along the sheltered side of the wharf at the west end of the island.

During a trip made in August of 1914 I failed to find the medusa at this place and was unable to locate it in the vicinity.

C. E. GORDON

AMHERST, MASS.

NOTE ON AMOEBA CLAVELLINÆ NOV. SP.

THIS species may be recommended to the attention of any worker desirous of investigating a parasitic Amœba which is visible *in vivo* within its host.

Its habitat is the stomach of *Clavellina lepadiformis*, where I noticed it from April to June, 1910, at Naples. The cilia of the stomach-wall keep it in constant rotation. When the host-individuals are small they are almost transparent, and the ceaselessly-whirling mass of parasites at once attracts attention.

In shape the organism is sub-spherical; pseudopodia were never observed. The average diameter varies from 12μ to 17μ . An ectoplasm may be present and sharply defined, or it may be totally absent. The nucleus is nearly spherical, with a diameter of 4μ to 5μ ; in it is

¹ "Medusæ of the World," 1910, p. 344

a nucleus of 2μ to $2\frac{1}{2}\mu$ diameter, containing a vacuole or two. The nuclear membrane is thick and definite. In the clear space between membrane and nucleolus is a band or ring of tangible material, usually in the form of fine granules. No division-figures or further stages in the life-history were noticed.

The few rough notes and figures which I possess relative to this animal would be freely put at the disposal of any one inclined to take up the study of the species.

JULIAN S. HUXLEY

THE RICE INSTITUTE,
HOUSTON, TEXAS,
November, 1914

ALBINISM IN THE ENGLISH SPARROW

ON several occasions during the past summer the writer saw a single female English sparrow (*Passer domesticus*) whose plumage was pure white. On account of the fact that the bird was seen on the busy streets of Salt Lake City, it was impossible to take it, due to the ordinance against the discharge of firearms within the city limits. The bird was observed from a distance of a very few feet, and seemed to be normal in size; the beak, legs and feet were nearly the color of those of the ordinary house canary, and, so far as could be observed, every feather was pure white. She was always seen in company with normal members of her own species.

I have never seen any reference to albinism in the English sparrow, but, no doubt, other observers have noted it. This note is published in the hope that others who have made like observations may advise us whether or not albinism is common in the English sparrow.

P. J. O'GARA

DEPARTMENT OF AGRICULTURAL INVESTIGATIONS,
AMERICAN SMELTING AND REFINING CO.,
SALT LAKE CITY, UTAH,
November 23, 1914

THE TEACHING OF THE HISTORY OF SCIENCE

TO THE EDITOR OF SCIENCE: The communication of Professor Walter Libby on the teaching of the history of science, published in your issue of November 6, deserves more than a passing notice. The obvious importance of such teaching led one of us more than twenty-

five years ago to begin regular instruction in the subject to small classes in the Massachusetts Institute of Technology, and both of the undersigned have now been teaching the history of science in collaboration for the last ten years or more. Like Professor Libby we have keenly felt the need of a text-book, and *faute de mieux* have now in hand the first of two volumes entitled "Outlines of the History of Science" designed expressly for the use of our own classes. Next summer we hope to have ready Volume I., dealing with the rise and progress of science and the scientific spirit to the fall of the Roman Empire. Volume II., treating of the development of science in medieval and modern times, should be ready a year later.

The course at the Massachusetts Institute of Technology is now an elective for all students in the third (junior) year and consists of one hour (lecture) and two hours (preparation) in the first half year, and two hours (lecture) and three hours (preparation) in the second half.

W. T. SEDGWICK,
H. W. TYLER

MASS. INSTITUTE OF TECHNOLOGY,
November 27, 1914

SCIENTIFIC BOOKS

Paul Ehrlich, Eine Darstellung seines Wissenschaftlichen Wirkens. Festschrift zum 60. Geburtstage des Forschers (14 März, 1914). Mit I Blidnis. Gustav Fischer, Jena, 1914.

Thirty-seven authors join their efforts in this book of 668 pages to present a summary of the investigations of Paul Ehrlich. The contributions of Ehrlich himself and of his immediate coworkers only are considered primarily, and according to the bibliography (up to February 1, 1914) at the end of volume, it concerns, in addition to several books and monographs by Ehrlich, no less than 612 separate scientific articles.

The book opens with an interesting biographical introduction by A. von Weinberg. In the gymnasium Ehrlich excelled in mathematics and Latin. In the university he early was recognized as of unusual ability and originality. While still a young medical student

he became interested in problems presented by the selective affinity of lead for certain tissues, an interest which soon extended to the problems of protoplasmic affinity in general and thus really determined the main scope and nature of his later work.

The main part of the book is divided into five sections covering different phases of Ehrlich's investigations. The first section is devoted to work that especially concerns the histology and biology of cells and tissues. Here is included Ehrlich's early work. Among the more notable results discussed in the seven articles of the section, the introduction to which is by Professor Waldeyer, of Berlin, may be mentioned: important discoveries in bacterial staining methods, now in daily use everywhere, in the working out of which Ehrlich cooperated with Koch; the microchemical differentiation of leucocytes; the demonstration of the methylene blue reaction of living tissues; and the development of new conceptions of the structure and function of protoplasm (Ehrlich's "Das Sauerstoffbedürfniss des Organismus," 1885), which form the basis of the celebrated sidechain theory advanced in the nineties to further the understanding of reactions in immunity.

The next and the largest section deals with Ehrlich's contributions to the study of immunity. It contains fifteen articles by well-known workers in the field in question. The side-chain theory, in the course of the proving of which so much of the work now considered was carried out, is discussed by Wassermann. Of the other subjects dealt with in this section may be mentioned the technical methods employed in the investigation of immunological problems, toxins, antitoxins and other antibodies, hypersusceptibility and the working out under the guidance of the side-chain theory of a practical method of standardization of diphtheria antitoxin. From the reading of these articles one is deeply impressed with the great usefulness of Ehrlich's theory of the constitution and affinities of protoplasm in promoting fruitful investigation of the complex problems in chemical biology presented by the phenomena of immunity. The imme-

diate practical results of this work are seen most clearly perhaps in the standardization of diphtheria antitoxin, as Ehrlich's method is used exclusively everywhere, but the influence of the work may be said to dominate in large measure every department of investigation of immunity and every branch of the practical application of the knowledge and principles derived therefrom.

The third section (three articles) considers Ehrlich's work on cancer, which forms a sort of interlude between the period of intensely active investigation of problems in immunity and the latest phase of his remarkable activity, namely the development of experimental chemotherapy. The principal outcome of the work of cancer is pointed out to be the demonstration that the cancer cell increases in power of growth on passage from animal to animal, and the formulation of the view that resistance to the growth of cancer cells, often observed in experimental inoculation, depends on the lack of available food-particles for the cancer cells (atropic immunity).

The two remaining sections of eleven articles deal with Ehrlich's contributions to chemistry and his chemotherapy of syphilis and certain other spirochetal infections. The development through a long series of systematic biochemical experiments, based on original conceptions of the affinities of cellular constituents, of a successful chemotherapy of important human infections, by direct attack on the parasites by substances specially built up for that purpose and introduced from without, is emphasized, and properly so, as the logical culmination of a unique investigative activity of the highest order. Even now Ehrlich's results fully justify Huxley's prediction in 1881 that through discoveries in therapeutics it would become possible "to introduce into the economy a molecular mechanism which like a cunningly contrived torpedo shall find its way to some particular group of living elements and cause an explosion among them, leaving the rest untouched."

Most of the articles are written by men who have worked under Ehrlich, and every now

and then we catch interesting glimpses of his picturesque and genial personality as well as hints to his methods of work. Naturally the many articles are not of the same merit and interest, but altogether they give us a very good and comprehensive idea of the tremendous achievements of Paul Ehrlich.

LUDVIG HEKTOEN

Infection and Resistance. By DR. HANS ZINSSER, Professor of Bacteriology at the College of Physicians and Surgeons, Columbia University, New York. The Macmillan Company, 1914.

The purpose of Dr. Zinsser's book of 546 pages is to render easily accessible the knowledge that has accumulated especially from laboratory work in regard to the intimate mechanisms of infection and immunity. There are twenty-one chapters: infection and the problem of virulence; bacterial poisons; immunity in general, natural and artificial; the mechanism of natural immunity, and the phenomena following on active immunization; toxin and antitoxin; bactericidal properties of serum and cytolysis; complement fixation (two chapters); agglutination; precipitation; phagocytosis (five chapters); anaphylaxis (five chapters); therapeutic immunization in man; protective ferments; colloids. The last chapter, on colloids, which is very useful in view of the many allusions in the other chapters to the analogies between colloidal reactions and the reactions between the substances concerned in the phenomena of immunity, is written by Professor Stewart W. Young. As each chapter so far as possible has been prepared as a separate unit, more or less repetition could not be avoided, but as compensation there is increased clearness in the presentation of each subject. We are told in the preface that the book is intended primarily for the undergraduate medical student, and the author replies to anticipated criticism of his treatment as being too difficult and too technical for the student by saying that his experience in teaching does not indicate such to be the case. Herein the reviewer is inclined to agree with

the author, but at the same time it must be said that more attention has been given to the details of certain controversies and experiments now largely of historical interest only than might be regarded as required in a book like this. This fondness for detail, however, does not detract seriously from the usefulness of the book to student and practitioner. The references to original sources are very abundant and will prove of great help, but they are not given according to any accepted bibliographic standard, the page being omitted in most cases. There are altogether but very few books that attempt to give a comprehensive summary of immunological knowledge of the same general scope as this one by Dr. Zinsser, but their number is increasing; for the present Dr. Zinsser's is the most serviceable.

LUDVIG HEKTOEN

The Norwegian Aurora Polaris Expedition, 1902-03. Vol. I.: On the Cause of Magnetic Storms and the Origin of Terrestrial Magnetism. By KR. BIRKELAND. Second Section. Christiania, H. Aschehoug & Co. 1913. 4°. Pp. x+319-801, with many maps and plates.

Five years have elapsed since the publication of the first section of the present work, yet, in spite of incessant labor, this second section could not be sooner completed. This was due to the great number and variety of the computations and experiments necessary. The author considers that the results attained by the investigation of conditions during positive and negative Polar storms, and particularly the diurnal motion of the respective magnetic storm centers, are so valuable as to fully compensate for the exertions and personal sacrifices that the work has cost.

In order to make it clear whether his conclusions from widely spread observations in different parts of the world could be harmonized with his previous theoretic assumptions, he has carried out a long series of experiments with a "terrella" or magnetic globe suspended in a large vacuum-box intended for electrical discharges. He has thus been able

to obtain photographic representation of the way in which cathode rays move singly, and group themselves in crowds about such a magnetic globe. Special study has been made of these groups of rays which produce magnetic effects analogous to those observed upon the earth during positive and negative magnetic polar storms. The photographic plates of these experiments are veritably fascinating.

The author holds that he has demonstrated that the magnetic storms on the earth, polar and equatorial, may be assumed to have as their primary cause the precipitation toward the earth of heliocathode rays, of which the magnetic rigidity is so great that the product $H \cdot \rho$ for them is usually about 3×10^6 C.G.S. units. He discusses the objections raised to this theory by Schuster and Hale, and states that the experiments which were originally intended to procure analogies capable of explaining terrestrial phenomena, such as the Aurora and "magnetic storms," were afterward continued to derive information in regard to the conditions under which the emission of the assumed heliocathode rays from the sun might be supposed to take place. The terrella was made the cathode in the vacuum chamber and experiments carried on for many years. In this research there gradually appeared experimental analogies to various cosmic phenomena, such as zodiacal light, Saturn's rings, sun spots and spiral nebulae. Whatever be the fate of the author's hypotheses the facts recorded in this work are well worthy the careful study of those interested in electromagnetism.

W. H. DALL

Physics of the Household. By CARLTON JOHN LYNGE, Macdonald College, Canada. 1914. 12mo. Cloth. Pp. 313.

Professor Lynde's book indicates that the author believes in teaching physics by consulting and describing, first, the student's own environment in information, experiences and appliances. These things are the fundamentals of this book. The reasons assigned in the preface for the teaching of physics to young students are, "First, that they may ob-

tain knowledge of the physical world about them; and, second, that they may gain through this knowledge the power to control the forces of nature for their own benefit, and for the benefit of others. In other words, we wish them to acquire knowledge which they will use in every-day life."

This work with other recent publications from a similar point of view represents a reaction against the prevailing formal text-books and formal treatment for beginners in the study of science. Those who consider fundamental things in physics to be the laws and generalization of the science will, perhaps, feel that the traditional logical development is very much neglected at some points. On the other hand, there is a growing demand among experienced teachers and critics of educational efficiency for a readjustment of text-book treatment. Where the strictly logical conflicts with what is considered profitable educational procedure the tendency is to defer logical organization of subject-matter till later. Experienced teachers, critics of education and the general public are demanding less drill work in abstraction and more practical work dealing with experiences and appliances such as one encounters in the world of reality. Lynde's book is a valuable contribution to the problem of teaching physics in a more practical way.

The first two chapters deal with a multitude of familiar mechanical contrivances, with discussions of the lever principle and other simple machines. This reminds one of the popular old text-books on natural philosophy of fifty or seventy-five years ago, and it is an altogether desirable revival. The chapter on mechanics of liquids is introduced with discussion of a city water supply, water supply for country homes, wells, etc. Following a chapter dealing with atmospheric pressure a variety of air appliances are discussed, including pumps, the pneumatic tank system of water supply for homes, the hydraulic ram, the air-pump, types of vacuum cleaners, the fire extinguisher, the siphon, the trap, the gas meter, etc. In the chapters on heat a similar list of important familiar appliances are to be

found. As a rule the author presents a descriptive treatment of a series of practical physical situations in order to form a basis for discussion of the principles involved.

The chapters on electricity, light and sound follow more closely the customary treatment and contain less of the distinctive feature of the first half of the book. For the sake of consistency in the general plan there is much material of a practical and illustrative nature that should have been incorporated in these latter chapters. It is somewhat disappointing to find a commendable book with so many amateurish free-hand drawings.

F. F. GOOD

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

THE FORSYTH DENTAL INFIRMARY FOR CHILDREN

THIS Boston institution, pioneer among charities for the adequate care of the mouths and throats of the children, poor or rich, of a large city, was dedicated formally by the Governor and others on Tuesday, November 24, and began its actual work the first of December. It is in the form of a splendid memorial erected by Thomas Alexander Forsyth and John Hamilton Forsyth to their brothers, James Bennett Forsyth and George Henry Forsyth, of whom, however, at present only the first-named is living. The amount already provided for this important work, it is understood, in the building and in endowment, is well along towards three millions of dollars.

Beautiful bas-relief bronze doors ("The Mother, giver of life and love" and "The Commonwealth, giver of health and learning") by Roger Noble Burnham, a bronze bust of James Forsyth by Bela Pratt and one of George Forsyth by Mr. Burnham, and charming Dutch and American tiling of elaborate design (A. H. Hepburn), are perhaps chief among the internal works of art of the beautiful white marble building, situated on The Fenway, north of the Museum of Fine Arts, although bronze doors ("Uncle Remus," "Bre'r Rabbit," "Alice in Wonderland," etc.), also ornament the entrance-way for the chil-

dren-patients from Forsyth Park on the north. The land on the south side of the hospital is also to be parked by the city.

The therapeutic and surgical outfit of this perfectly fire-proof infirmary may not be adequately described in this place. Suffice it that its present means for caring for six hundred patients a day are the most timely and complete that expert technical thought and information, served with unlimited funds, could provide, so that several features wholly new have their place in this institution. The sixty-eight (at present) dental chairs, for example, in the great operating room, are the most elaborate ever constructed, for each has running water warmed to suit the requirements of a tooth-cavity, compressed air, air-suction, electricity, an electric signal system, etc., while many of them are equipped with the most recent of anesthesia-mechanisms; all are finished throughout in white-enameled metal, in line with modern ideas toward asepsis. The dental instruments which have been used for a patient are enclosed in a flat covered metallic tray and sent to the sterilizing-room, where each night they are in tiers subjected to dry heat at 300° F. in gas, thermostat-controlled ovens. This careful system of asepsis will require the daily use of a thousand sets of dental instruments when the number of chairs has been increased to the capacity of the Infirmary.

The arrangements for amusing the children while awaiting their unpleasant experiences in the dental chairs or in the nose-and-throat department (which is very elaborate and complete) are a noteworthy part of this institution quite in line with modern medical principles of good humor and the related sthenic index. The little patients (none over sixteen), have a large room, known as the "Children's Room," close to their special entrance which is quite after their own youthful hearts. Miss Tower, a skilled kindergartner, here makes it her sole business to see to it that the children forget for the time why they are come hither and the approaching disagreeable duty of having one's teeth put in order or one's throat "treated." Here, for example, is an

alluring aquarium nine feet long and three feet square, two thirds of which is for graceful plants and a few score of our more interesting native fish in large variety, while one third is a reptile-tank so built and arranged as to at once display and make comfortable all manner of American amphibious little beasts. Here, too, is a library of story-books, games, etc., and later on there will be other things as actual experience shows their need. Around the walls of this children's room are extremely elaborate friezes of Delft tiling illustrating some familiar fairy stories—Oliver Wendell Holmes's "Dorchester Giant," "Rip Van Winkle," Hawthorne's "Golden Fleece," and Mrs. Prescott Peabody's "Pied Piper."

Connected with the Children's Room is a metallic cloakroom so constructed that its entire contents can be fumigated and thus sterilized at night, electric pumps forcing in and removing the respective atmospheres at the instigation, respectively, of two push-buttons. The plumbing everywhere is extensive and to some extent original and unique. There is a small ward for the girls who may chance to need its care and a like one for the boys; and there is of course a small but adequate amphitheater for the professional study of oral or of nose- or throat-operations; and a large research laboratory; there is much museum-space; a library; and a lecture-room that will seat about three hundred persons.

In addition to a large number of routine operating dentists (some of whom work full-time and others half-time or third-time) the following at present constitute the staff of the Forsyth Infirmary: Director, Dr. Harold De Witt Cross; assistant to the director, William Z. Hill; nose and throat department, William E. Chenery; consulting otologist, Edgar M. Holmes; extracting staff, Edward V. Bulger and eleven others; X-ray department, Arial W. George, consultant; E. Albert Kinley, Jr.; consulting surgeons, Fred B. Lund, Harry H. Germain, Hugh Cabot, and Hugh Williams; consulting physiologist, George V. N. Dearborn; oral surgeons, Albert Midgley, Harry B. Shuman, Leroy M. S. Miner and B. H. Strout; orthodontia, Frank A. Delabarre,

head of department; consulting orthodontists, George C. Ainsworth, Alfred Rogers and Lawrence W. Baker; assistants, Arthur L. Morse, Harry W. Perkins, Ernest W. Gates and Norman G. Reoch.

The trustees of the institution, besides Thomas Alexander Forsyth, Director Cross and John Francis Dowsley, the president of the State Board of Registration in Dentistry, are Edwin Hamlin, Chester Bradley Humphrey, Edward Walter Branigan (deceased), Harold Williams, Timothy Leary, Gordon Robert McKay, Erwin Arthur Johnson and Nelson Curtis. Theirs is a good work well begun.

G. V. N. D.

FIRST EXPLORATION OF AN ALASKAN GLACIER

THE first exploration of the Harvard Glacier and the continuation of the observations of previous scientific expeditions in regard to the great glaciers of Prince William Sound, Alaska, have resulted from a field expedition recently completed by Miss Dora Keen, of Philadelphia, with the aid of three men.

Leaving Valdez, Alaska, on August 15, 1914, in a small launch, the party was set down next day near the head of College Fjord, with six weeks' outfit and two small boats, to one of which a detachable motor was affixed. The object of the expedition was twofold: (1) to explore the sources of the Harvard Glacier in the unmapped section of the Chugach Mountains. If a pass were found, it was planned to cross the divide and return to tidewater down the Matanuska Glacier and the Valley trail of the same name—a traverse of some 50 miles of snow and ice, almost entirely without timber, and a succeeding 100 miles of a hard trail chiefly through uninhabited country. (2) To continue the observations of the changes taking place in the glaciers of College Fjord and Harriman Fjord, by means of photographs taken from lettered stations variously occupied since 1899 by the Harriman Expedition, U. S. Geological Survey, and the National Geographic Society's Expeditions. Both of these objects were accomplished, in spite of

almost constant rain or snow, during an expedition that lasted six and a half weeks actually in the field.

The expedition was a private one, but undertaken at the suggestion and under the guidance of the junior leader of the National Geographic Society's Expeditions, Professor Lawrence Martin, of the University of Wisconsin. The party consisted of Miss Keen, leader, whose previous experience had been on the glaciers of the Alps and in two extended expeditions in Alaska, entirely on the glaciers of the Wrangell Mountains and resulting in the first ascent of Mt. Blackburn, 16,140 ft.; Mr. G. W. Handy, of McCarthy, Alaska, who had been responsible for the success of her second attempt on Mt. Blackburn; G. A. Rabehl, also an old timer in Alaska, and Mr. H. L. Tucker, of Boston, topographer, whose previous experience had been on the 1910 Parker-Browne Expedition to Mt. McKinley and with the Yale Peruvian Expedition on Coropuna, 21,000 feet.

Exploration of the Harvard Glacier

The Harvard Glacier has a tidal ice cliff a mile and a quarter wide and 350 ft. high, from which ice breaks constantly in summer, causing danger to small boats. Still, a landing was effected in safety on one side and supplies gradually relayed to a point seven miles from the face, where the ice was at last smooth enough to make travel on the glacier itself possible. Over another nine miles of crevasses the party succeeded in reaching the sources of the glacier, to a point where further progress was impossible, even on snowshoes, because of the shattered condition of the glaciers flowing from the steep divide. No pass being found, the return was made from this point, by the same route. All the way, food, tents, etc., and for most of the distance fuel, had to be relayed on the backs of the party, and all the going was hard, so that three and a half weeks were spent in reaching an altitude of 6,100 feet, sixteen miles from the face of the ice.

Danger from snow slides also prevented any high ascent, but data of value were secured

from which the first map of the region will be prepared. Observations of snowfall and temperatures will also throw light on the alimentation of the glacier and its many tributaries.

Photographs of the Glaciers of Prince William Sound

Observations of some 20 glaciers in College Fjord, Harriman Fjord and Columbia Bay constituted the second part of the work, which is a continuance of the study of the advance and recession of these glaciers with a view to determining their causes. Some glaciers appear to have receded as much as a quarter of a mile in a year, while others near-by seem to have advanced as great an amount.

In spite of great difficulty and some risk in forcing a frail row-boat through solid jams of icebergs, which threatened to crush it, this part of the expedition also was accomplished without accident.

SPECIAL ARTICLES

AN EARLY OBSERVATION ON THE RED SUNFLOWER

UNTIL the present month (November, 1914) I supposed that the red sunflower found at Boulder was the first of its kind ever seen by a botanist. I have, however, recently learned from Dr. David Griffiths, of the U. S. Department of Agriculture, that as long ago as 1892 he found a few plants of the wild annual sunflower on the Missouri River bottom in Potter County, South Dakota, having the rays marked at the base with maroon, about the same color as is seen in the dark forms of *Lepachys*. Again, in 1897, he saw in the Sundance region of Wyoming (probably within 15 or 20 miles of Sundance) a single plant having the rays maroon, with only a narrow fringe of yellow. Dr. Griffiths discussed the matter with Mr. T. A. Williams, who had also seen a plant somewhere, he thinks in the Bad Lands of South Dakota. It thus appears that the red sunflower has arisen independently as a "sport" in at least three widely separated places, a fact which may have a certain bearing on the suggestions of Professor Bateson regarding its nature. It is to be noted that the two cases reported by Dr. Griffiths represent

different subvarieties, both different from the original Boulder one.

In *Botanical Gazette*, October, 1914, Professor E. C. Jeffrey has a very interesting article on the relation between hybridism and imperfection of pollen.¹ The various forms of red sunflowers which have been developed for horticultural purposes result from crossing the original wild sport of *Helianthus lenticularis* with various garden forms ascribed to *H. annuus*. Speaking broadly, these crosses, in all directions and through several generations, have been perfectly fertile, at least in the sense that they have produced abundant seed. Deficiency of pollen has however been common, especially in dark red varieties and doubles. My wife, who made the crosses, was sometimes unable to get pollen from some of the most beautiful plants, though she could obtain seed from these by using pollen from others. According to Dr. Jeffrey's criteria, this might seem to indicate that *H. lenticularis* and *annuus* are distinct species, although in this case it seems nearly certain the species *annuus* arose in cultivation. It is possible, of course, that the prairie sunflower, *H. lenticularis*, is a mixture of more or less different things. Thus we obtained seed of the wild Californian form, which appeared to be true *lenticularis*, but had the physiological peculiarity of remaining in flower after the Colorado plants were over. If, however, the present red sunflower of horticulture is in any sense a "crypt-hybrid," it certainly presents a very different case from the hybrids between it and the undoubtedly distinct species *H. cucumerifolius*. These latter hybrids, of various kinds according to the particular varieties used, are some of them very attractive. They can be produced in quantity as F_1 plants, but so far it has proved impracticable to get enough F_2 seed for horticultural purposes. The behavior here is much more like that usually expected of hybrids.

¹ With regard to *Sorbus*, which is specially cited by Dr. Jeffrey in illustration of his theory, it is to be noted that this genus was apparently producing hybrids in Miocene times. (*Amer. Jour. Science*, Jan., 1910, p. 76.)

A paper by Dr. G. H. Shull² on the apparent independence in inheritance of the stem and bud colors (anthocyan) in *Oenothera*, suggests a reference to the condition found in the new garden sunflower with wine-red on the rays. The more usual red (chestnut red, *i. e.*, red on orange) variety can nearly always be recognized in the seedling stage by the dark purple stems, a fact of utility in horticultural practise. To our surprise, when we came to raise the wine-red (red on primrose yellow) form in quantity, we found that the purple-stem character failed, in spite of the fact that the history of the plant indicated that it differed from the other red one in the yellow background, not at all in the anthocyan factor. Mr. Leonard Sutton, who grew the wine-red variety in England from our seed, also reports: "It is a remarkable fact, as you mention, that the purplish color is not shown in the stems of this new variety."³ The question naturally arises, whether in such a case it is necessary to assume a splitting or complexity of the factor representing anthocyanin; whether it is not equally possible that some condition has arisen controlling the expression of the factor for red, that factor remaining genetically the same? In the course of breeding plants, we are doubtless too apt to assume that our recorded data represent the whole of the pertinent facts. It is evident that any given plant represents, in addition to the known "units," an assemblage of others which are unknown or merely suspected, while the known ones may have unknown properties. Thus, in spite of records and observations, the stage may be invaded at any moment by unnoticed *dramatis personae*, and the development of the plot may belie the promise of the first acts.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

November 29, 1914

A REMARKABLE MICROSAUR FROM THE COAL MEASURES OF OHIO

THE Amphibia of the American Coal Measures as now known are represented by eighty-eight species, representing seventeen families

² *Journal of Genetics*, June, 1914.

³ Letter of September, 1914.

and five orders. All of the species of *Branchiosauria* and all of the hitherto recognized *Microsauria* are uniform in the absence of an osseous carpus and tarsus. It is thus with considerable interest that we find an osseous tarsus in a microsaurian species from Linton, Ohio. The species was described many years ago by Cope¹ and it has not since been studied until Professor Grabau recently forwarded the type specimen to me from Columbia University where it forms a part of the geological collections.

Ichthycaanthus platypus, referred by Cope to the Permian genus *Eryops*, is a small microsaur which in life probably did not attain a length of more than eight inches but was of a very active nature, as seems to be indicated by the scanty remains preserved, which consist of the posterior half of the body.

At first glance the specimen recalls a reptile, such as *Eosauravus Copei* Will., but closer examination reveals remarkable differences. The femur, in its well-ossified condition and the high degree of development of the trochanters, is typically reptilian; and there is nothing strikingly amphibian in the tibia and fibula. The tarsus, however, is reptilian with its central, and the distal row being composed of five elements. All of the elements are well ossified and articulate with phalanges which have a typical amphibian arrangement with the formula 2-2-3-3-2. The sharply clawed ungual phalanges add to the anomalous nature of the species.

The recognition of the exact nature of this species adds considerably to our knowledge of the diversity of structure among the Coal Measure Amphibia. Environmental conditions prior to the Coal Measures had effected a wide diversity of structure within the group. So early in the geologic history of the land vertebrates as the Pennsylvanian the Amphibia had assumed a variety of forms which had specialized into strictly aquatic, terrestrial, sub-terrestrial and arboreal. Specialization had extended to the loss of limbs, ribs and

¹ Cope, E. D., 1877, *Proc. Amer. Phil. Soc.*, p. 574; 1888, *Trans. Amer. Phil. Soc.*, p. 289, Fig. 1.

ventral armature, in a few species, and to the acquirement of claws, running legs or a long propelling tail with expanded neural and hemal arches in others. This wide diversity of structure is intensified by the recognition of *Ichthycaanthus platypus* as a microsaur with an osseous tarsus, serving to confuse still further our hazy ideas of amphibian phylogeny.

A full description with illustrations will be given of this interesting form in another place.

Roy L. Moodie

UNIVERSITY OF ILLINOIS,
CHICAGO

THE OHIO ACADEMY OF SCIENCE

THE twenty-fourth annual meeting of the Ohio Academy of Science was held at Ohio State University, Columbus, Ohio, on November 26, 27 and 28, 1914, under the presidency of Dr. T. C. Mendenhall, of Ravenna.

The address of the president was delivered Friday evening, on the subject "Some Pioneers of Science in Ohio"; and on Saturday morning the academy listened to a very timely lecture upon "Foot and Mouth Disease," by Dean D. S. White, of the College of Veterinary Medicine of Ohio State University.

The trustees of the research fund announced a further gift of \$250 from Mr. Emerson McMillin, of New York, for the encouragement of the research work of the academy.

In accordance with the report of a committee appointed a year ago, the academy voted to deposit the library of the academy with the library of Ohio State University—an arrangement which may be terminated by either party on suitable notice.

The matter of the celebration of the annual meeting of 1915 as a quarter centennial anniversary was referred to the executive committee.

Twenty-three new members were elected, making the total membership of the academy two hundred and fifty-four.

The officers of the academy for the year 1914-1915 are as follows:

President—Professor J. Warren Smith, Ohio State University and Ohio Section U. S. Weather Bureau.

Vice-presidents—(Zoology) Professor F. C. Waite, Western Reserve University; (Botany)

Professor F. O. Grover, Oberlin College; (Geology) Professor C. G. Shatz, Wittenberg College; (Physics) Professor J. A. Culler, Miami University.

Secretary—Professor E. L. Rice, Ohio Wesleyan University.

Treasurer—Professor J. S. Hine, Ohio State University.

Librarian—Professor W. C. Mills, Ohio State University.

Executive Committee, together with the president, secretary and treasurer, members ex officio—Professor C. D. Coons, Denison University; Professor T. M. Hills, Ohio State University.

Board of Trustees of the Research Fund—Professor W. R. Lazenby, Ohio State University; Professor M. M. Metcalf, Oberlin College; Professor N. M. Fenneman, University of Cincinnati.

Publication Committee—Professor J. H. Schaffner, Ohio State University; Professor C. H. Lake, Hamilton; Professor L. B. Walton, Kenyon College.

The complete scientific program follows:

Presidential Address, "Some Pioneers of Science in Ohio," Dr. T. C. Mendenhall.

Lecture, "The Foot and Mouth Disease," Dean D. S. White, College of Veterinary Medicine, Ohio State University.

Papers

"Efficacy of Lightning Rods," J. Warren Smith.

"Thunderbolt from Whitecliff Bay," Katharine Doris Sharp.

"A Preliminary Survey of Plant Distribution in Ohio," John H. Schaffner.

"Akron Fishbait Industry," Chas. P. Fox.

"The Physiographic Provinces which meet in Ohio," N. M. Fenneman.

"Color and Coat Inheritance in Guinea Pigs," W. M. Barrows.

"Note on a New Nematode Parasite of *Cryptobranchus*," F. H. Krecker.

"Prediction of Minimum Temperatures for Frost Protection," J. Warren Smith.

"Is a Dry Summer and Autumn Apt to be Followed by a Wet Winter and Spring with Possible Floods?" J. Warren Smith.

"Comparative Rate of Growth of Certain Timber Trees," William R. Lazenby.

"Inheritance of Taillessness in the Cat," W. M. Barrows and C. A. Reese.

"The Cause of Milk Sickness and Trembles," E. L. Moseley.

"Notes on Euglenoidina," L. B. Walton.

"Recent Eruptions of Mount Lassen," Thos. M. Hills.

"Glaciation in the High Sierras," Thos. M. Hills.

"Inheritance of Weights in Tomatoes," Fred Perry.

"The Municipal Care of Shade Trees," J. S. Houser.

"Influence of Glaciation on Agriculture in Ohio," Edgar W. Owen.

"The Reflection of X-rays and Gamma Rays from Crystals" (introducing discussion), S. M. J. Allen.

"A Class Demonstration of the Peltier Effect," J. A. Culler.

"Behavior of the Arc in a Longitudinal Magnetic Field," R. F. Earhart.

"Effect of Heat Treatment on the Physical Structure, Permeability, and Hysteresis of Steel," R. J. Webber.

"The Electron Theory of Metallic Conduction," (introducing discussion), A. W. Smith.

"The Effect of Changes in Water Resistance and Dielectrics on the Vibrations of a Lecher System," Geo. W. Gorrell.

"Exhibit of Apparatus for Electric Waves: (1) Drude Apparatus for Refractive Index of Electric Waves. (2) A Wavemeter for Wireless Frequencies," A. D. Cole.

"Some Additions to the Known Orthopterous Fauna of Ohio," W. J. Kostir.

"Ohio Spiders," W. M. Barrows.

"The Egg Capsules of a Bdellodrilid on the Crayfish," Stephen R. Williams.

"Observations on the Life Histories of Jassidae and Cercopidae," Herbert Osborn.

"Habits and Food of the American Toad," Rees Philpott.

"Note on the Occurrence of *Demodex folliculorum* var. *bovis* in Ohio," D. C. Mote.

"Arrangements of the Muscles in the Mouth Parts of Embryo Cockroaches and its Bearing on the Phylogeny of the Hexapoda," L. B. Walton.

"Winter Record of King Rail in Ohio," Edward L. Rice.

"On the Synthesis of Proteins," A. M. Bleile.

"Additions to the List of Heteroptera of Ohio," Carl J. Drake.

"The Cranial Nerves of an Embryo Shark," F. L. Landacre.

"Myxomycetes of Northern Ohio," E. L. Fullmer.

"The Forest Types of the Ohio Quadrangle," Forest B. H. Brown.

"New and Rare Plants Added to the Ohio List in 1914," John H. Schaffner.

"A Provisional Arrangement of the Ascomycetes of Ohio," Bruce Fink.

"The Collemaceae of Ohio," Bruce Fink.

"Notes on Ohio Higher Fungi," Wilmer G. Stover.

"The Leaf Mold Disease of Tomato (*Cladosporium fulvum*)," Wilmer G. Stover.

"Summit County Marl," Chas. P. Fox.

"History of the Olentangy River Below Delaware, Ohio," L. G. Westgate.

"The Physiography of Mexico," Warren N. Thayer.

"Notes on Some Richmond Fossils," W. H. Shideler.

"The Classification of the Niagaran Formations of Western Ohio," Charles S. Prosser.

"The Defiance Moraine in Relation to Pro-Glacial Lakes," Frank Carney.

"Some of Dr. H. Herzer's Last Fossil Descriptions," W. N. Speckman.

"On the Origin of Oolite," Walter N. Bucher.

"Magnetic Rays" (introducing discussion), L. T. More.

"On the Free Vibration of a Lecher System," F. C. Blake and Charles Sheard.

"Measurements of the Magnetic Field," Samuel R. Williams.

"On the Radioactive Deposit from the Atmosphere on an Uncharged Wire," S. M. J. Allen.

"Demonstration of Simple Harmonic Motion on Rotation Apparatus," Charles Sheard.

Demonstrations

A Nematode Parasite of *Cryptobranchus*, F. H. Krecker.

Cross Sections Illustrating Rate of Tree Growth, William R. Lazenby.

Varieties of Domestic Guinea-Pigs, W. M. Barrows.

Tailless Cat, W. M. Barrows.

Orthoptera not Hitherto Recorded from Ohio, W. J. Kostir.

A Scale of Ohio Forest Types to Indicate the Fertility of Soil for Agricultural Crops, Forest B. H. Brown.

Photographs of Leaf Hoppers and Frog Hoppers, Herbert Osborn. EDWARD L. RICE, Secretary

DELAWARE, OHIO,
December 5, 1914